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Senate Outdoor Recreation and Tourism Committee

June 23, 2011

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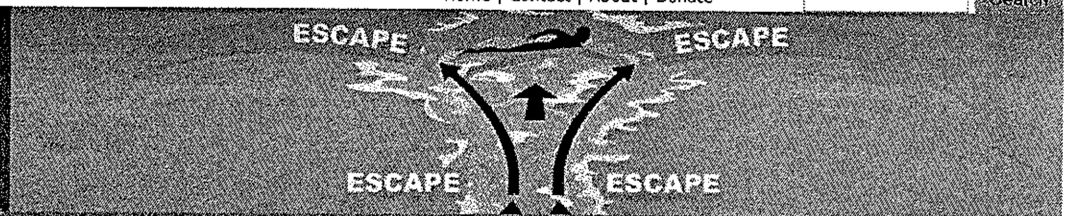
Sea Grant Michigan



Rip Currents

En Español
About Rip Currents
Beach Safety Tips
Beach Signs & Brochure

About Rip Currents

Great Lakes Swimmers: Beware of potentially deadly rip currents
A number of people have drowned in the Great Lakes, and experts believe a majority of these deaths probably happened because people panicked when a rip current pulled them from shore. Nationally, lifeguards rescue approximately 60,000 people from drowning a year, and an estimated 80 percent are caused by rip currents.

Signs that a rip current may be present

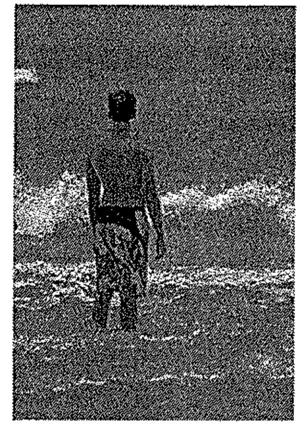
- A break in the incoming wave pattern
- A channel of churning, choppy water
- A line of foam or debris moving seaward
- A difference in water color

If caught in a rip current

- Stay calm
- Don't fight the current
- Swim in a direction following the shoreline (parallel)
- Float or tread water if you're unable to escape by swimming. When the current weakens, swim at an angle (away from the current) toward shore
- If you cannot reach shore, draw attention to yourself. Face the shore, call or wave for help

Helping someone else

- Many people have died while trying to rescue others caught in rip currents.
- Don't become a victim yourself. If a lifeguard is not present, shout directions on how to escape the current
- If possible, throw something that floats to the rip current victim
- Call 911



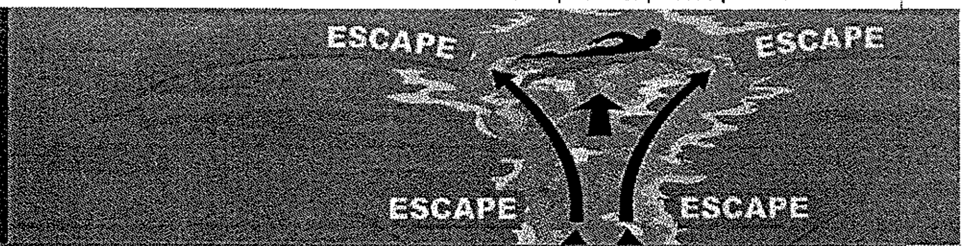
Water safety

An estimated 100 people drown from rip currents annually-more people than are killed by tornadoes or lightning.

- NOAA National Weather Service Rip Current
- United States Life Saving Association
- United States Coast Guard
- Article in June 2004 Upwellings

Michigan Sea Grant enhances the sustainability of Michigan's coastal communities, residents, and businesses through research, outreach and education.

Sea Grant Michigan



Beach Safety Tips

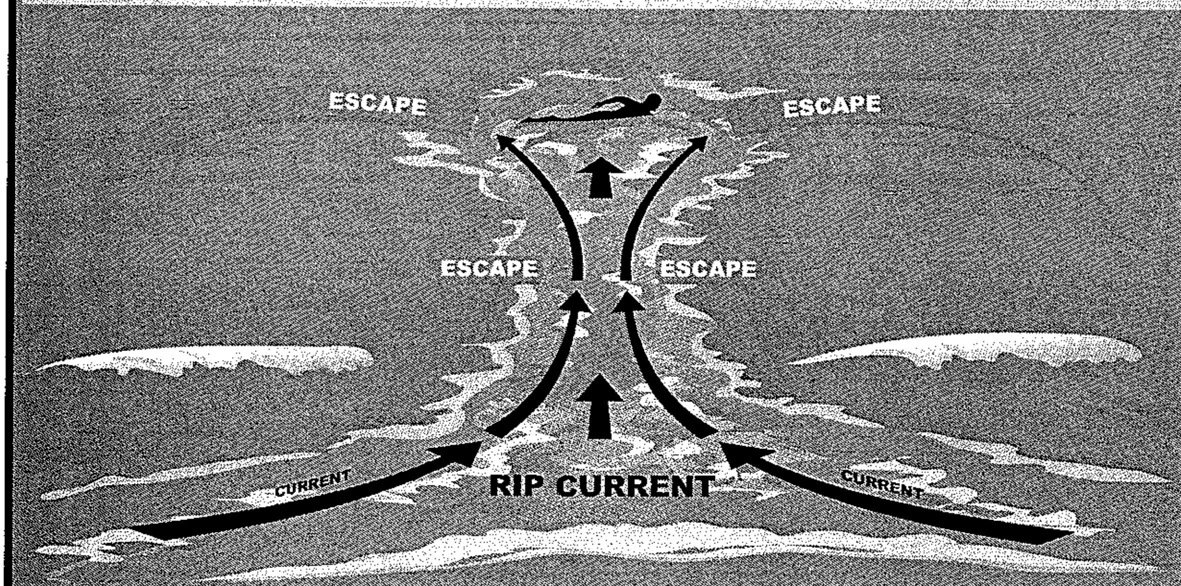
Help Save Lives: Steps Communities Can Take to Make Beaches Safer

- **Organize a beach safety task force in your area.** There are many such task forces across the country. Two Michigan organizations include: Pier Safety Task Force and the Mackinac County Water Safety Review Team.
- **Provide information to local citizens about water safety.** First responders on the scene of a swimmer in danger should call 911 and notify your local emergency response personnel of your exact location.
- **Install beach safety signage.** This signage focuses on rip currents, the most threatening natural hazard along beaches.
- **Purchase life-saving equipment** (life rings, cell phones, and other equipment). Make this equipment available at key points along beach areas, specifically for emergency situations. Several beach safety task forces have received foundation, private and corporate funding to purchase this equipment.
- **Distribute brochures** about the danger of rip currents and water safety. See: *brochures and signage*
- **Seek financial support for your efforts.** Many businesses, foundations, and private sources have provided support for water safety efforts.
- **Provide local media with information about rip currents and water safety** (photos, illustrations and factual information). See: About rip currents.

Michigan Sea Grant enhances the sustainability of Michigan's coastal communities, residents, and businesses through research, outreach

RIP CURRENTS

Break the Grip of the Rip!™



Rip currents are powerful currents of water moving away from shore. They can sweep even the strongest swimmer out to sea.

IF CAUGHT IN A RIP CURRENT

- **Don't fight the current**
- **Swim out of the current, then to shore**
- **If you can't escape, float or tread water**
- **If you need help, call or wave for assistance**

SAFETY

- **Know how to swim**
- **Never swim alone**
- **If in doubt, don't go out**

More information about rip currents can be found at the following web sites:

www.ripcurrents.noaa.gov
www.usla.org
www.miseagrant.umich.edu

NOAA

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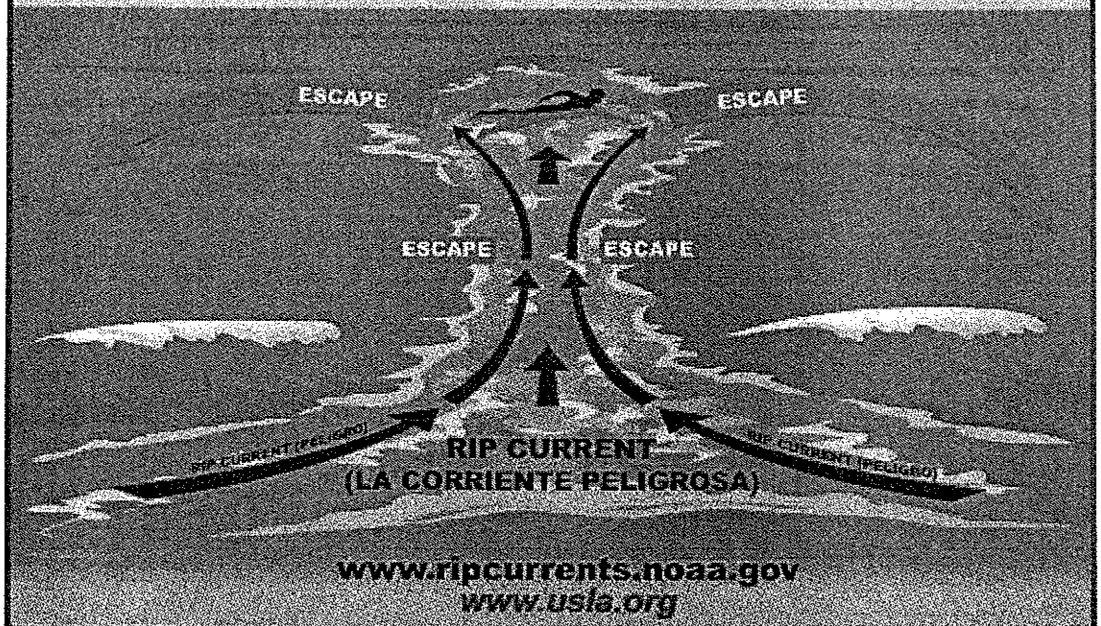
RIP CURRENTS
¡ESCÁPESE DE LA CORRIENTE!®



IF CAUGHT IN A RIP CURRENT
SI LO ATRAPA LA CORRIENTE PELIGROSA

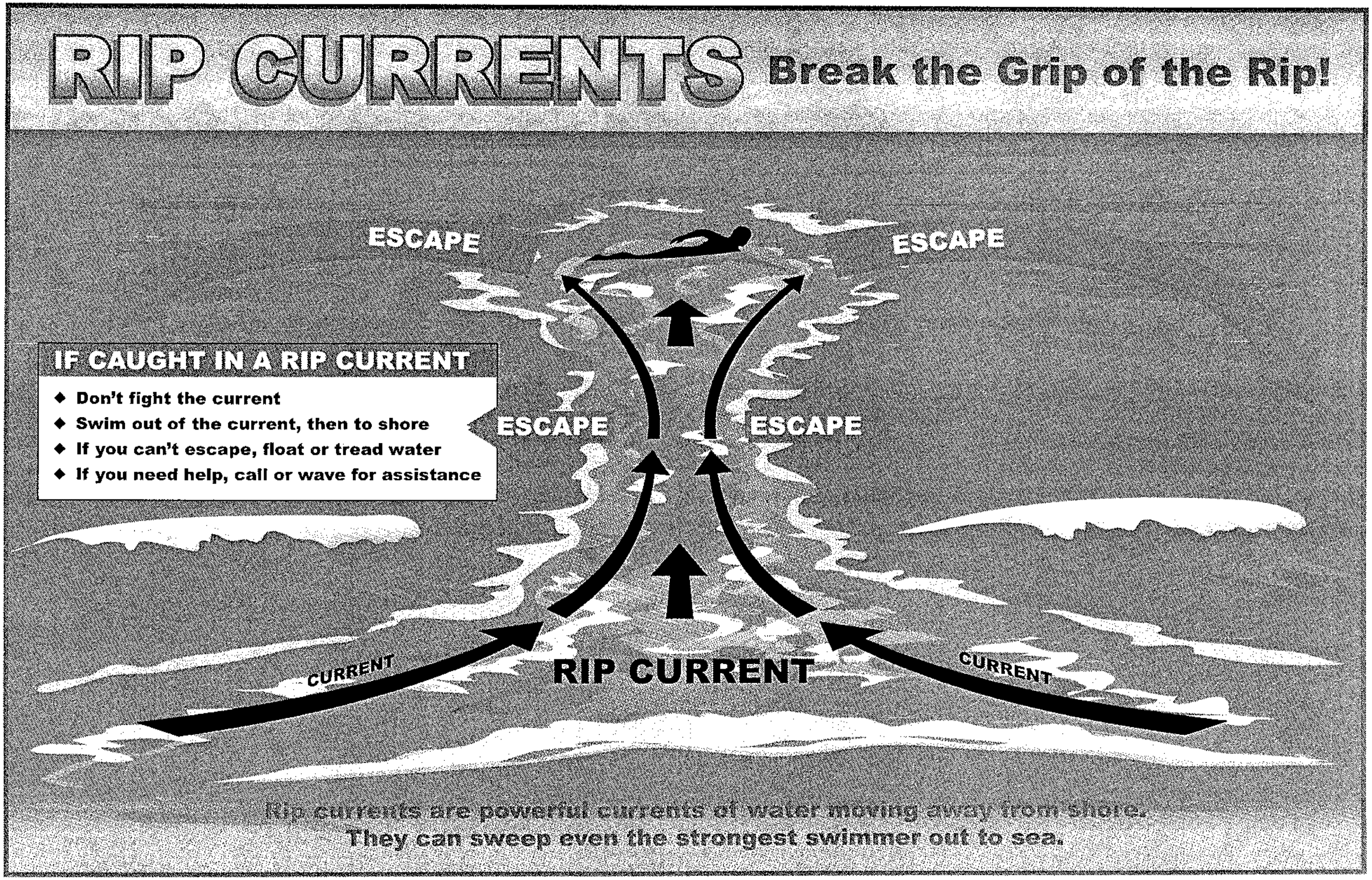
- **Don't fight the current**
  No luche contra la corriente
- **Swim even with the shore, until current weakens, then swim to shore**
  Nade al nivel de la orilla hasta que la corriente se debilite
- **If you can't escape, float or tread water**
  Si no logra escapar, mantengase a flote pedaleando
- **If you need help, call or wave for assistance**
  Si necesita auxilio, grite o agite los brazos

More information about rip currents can be found at the following web sites:
Para más información acerca de las corrientes peligrosas consulte estos sitios de web:

www.ripcurrents.noaa.gov
www.usla.org

Sea Grant

Never swim alone - *Nunca nade solo*


RIP CURRENTS Break the Grip of the Rip!
ESCAPE
ESCAPE
IF CAUGHT IN A RIP CURRENT
◆ Don't fight the current
◆ Swim out of the current, then to shore
◆ If you can't escape, float or tread water
◆ If you need help, call or wave for assistance
ESCAPE
ESCAPE
CURRENT
RIP CURRENT
CURRENT
Rip currents are powerful currents of water moving away from shore.
They can sweep even the strongest swimmer out to sea.

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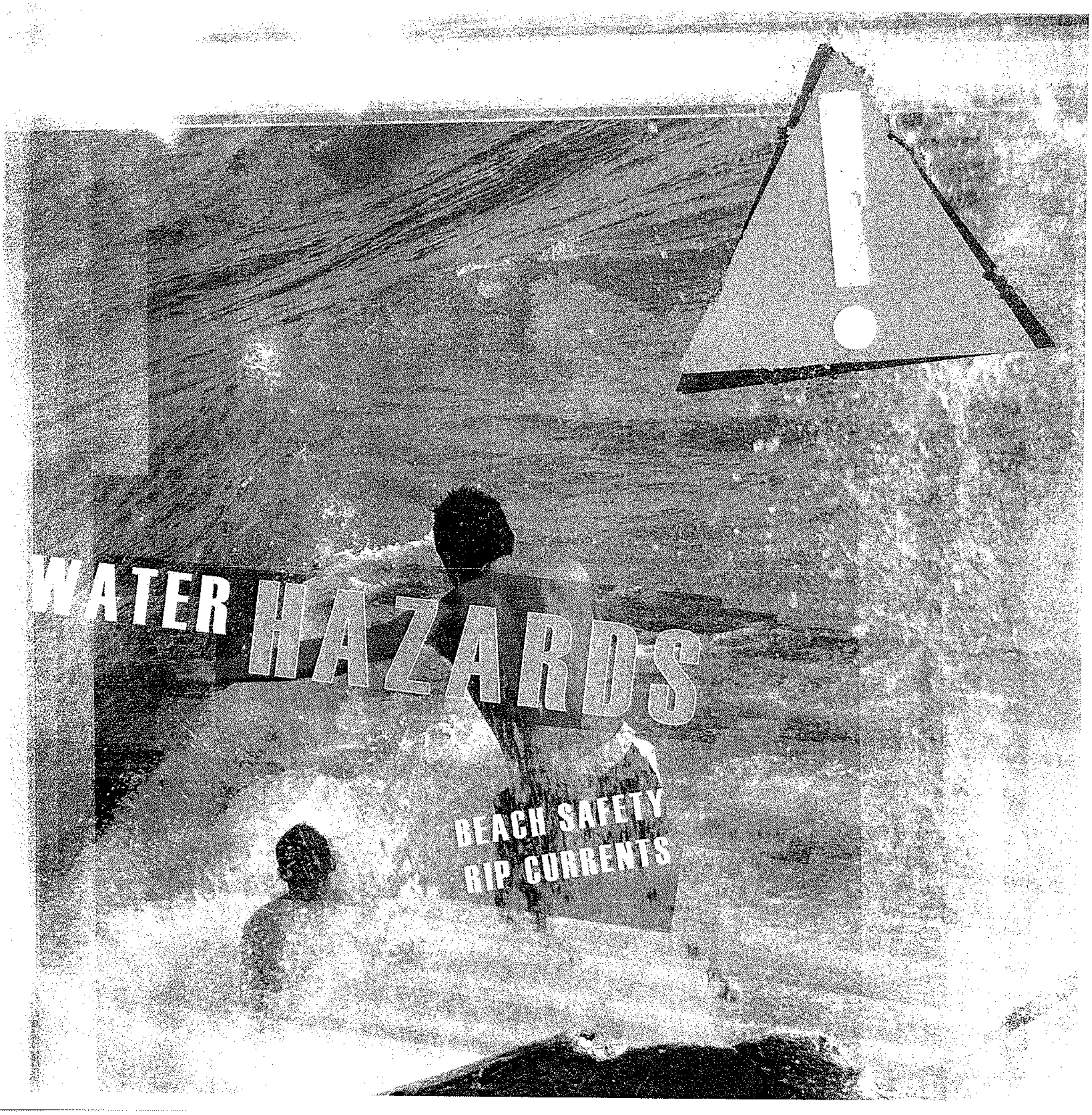
Upwellings

VOLUME 34 | NUMBER 2 | JUNE 2011



Upwellings

An upwelling occurs in a lake or ocean when strong, steady winds push warm in-shore surface water away from shore causing colder, nutrient-rich water to rise.

Upwellings is published quarterly by the Michigan Sea Grant College Program, a cooperative effort of the University of Michigan and Michigan State University. The program supports understanding and stewardship of the Great Lakes through research, outreach and education.

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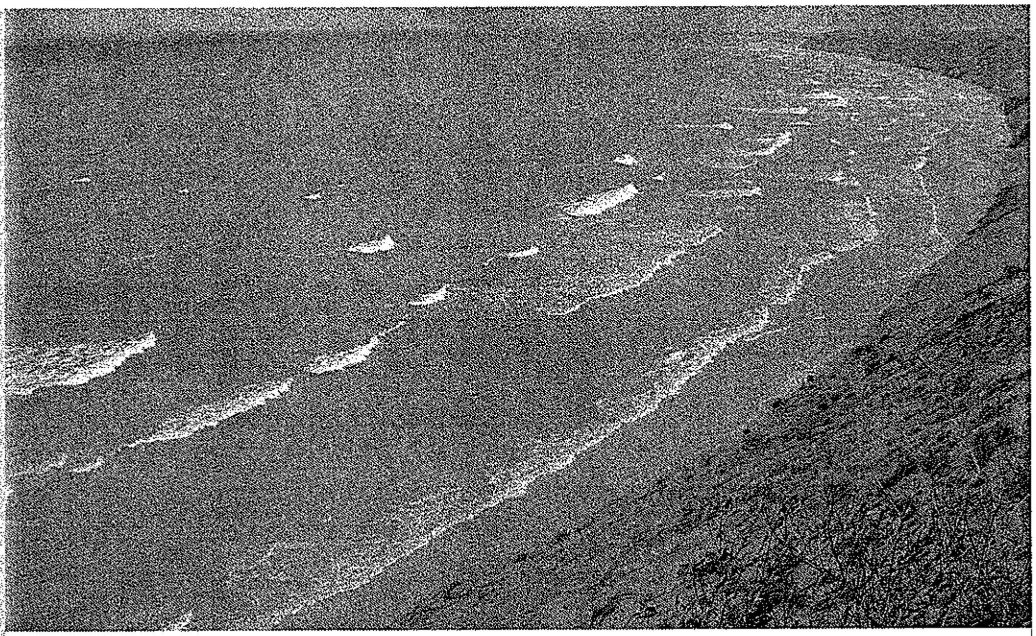

RIP CURRENTS? AGAIN?

Many things we do each day carry an inherent risk. Not to be all glum about it, but everyday activities like eating, taking the stairs or driving are somewhat risky when considering the things that could go wrong. Yet, we learn to survive. We learn to navigate the potential challenges, and we educate ourselves on how to respond should something go awry. The same should be said for beach and water safety.

For many, the beach is a state of mind. And Great Lakes beaches – surrounded by natural beauty and clear water so close to home – are no exception. So it's not surprising that people don't want to think about danger and hazards like rip currents when heading out to enjoy. The reality is, though, that a little bit of understanding and preparation can go a long way in keeping you safe at the shore.

After last summer's noteworthy year of drownings and rescues throughout the Great Lakes – more than 30 drowning deaths were attributed to dangerous current conditions – we decided to provide more information on currents again this season.

Since last May, communities have banded together to create plans of attack. There are more signs going up, more information is being distributed, and rip current awareness is being approached in many different and unique ways. The Great Lakes Water Safety Conference, mentioned in the "Against the Current" article (page 4), brought together leaders from different communities interested in learning what has worked, what hasn't, and where we go from here. The case study on Marquette, Michigan (page 5) profiles how one community has developed a comprehensive way of approaching waterfront safety.

The answer to the "rip currents again?" inquiry is a resounding yes. Water safety is a critical public safety issue. We want people to be able to enjoy the Great Lakes without being afraid, entering the water with confidence. In this issue of *Upwellings*, we have provided an overview on why education is necessary, what communities are doing and where to find more information on dangerous currents.

— *Stephanie Ariganello*

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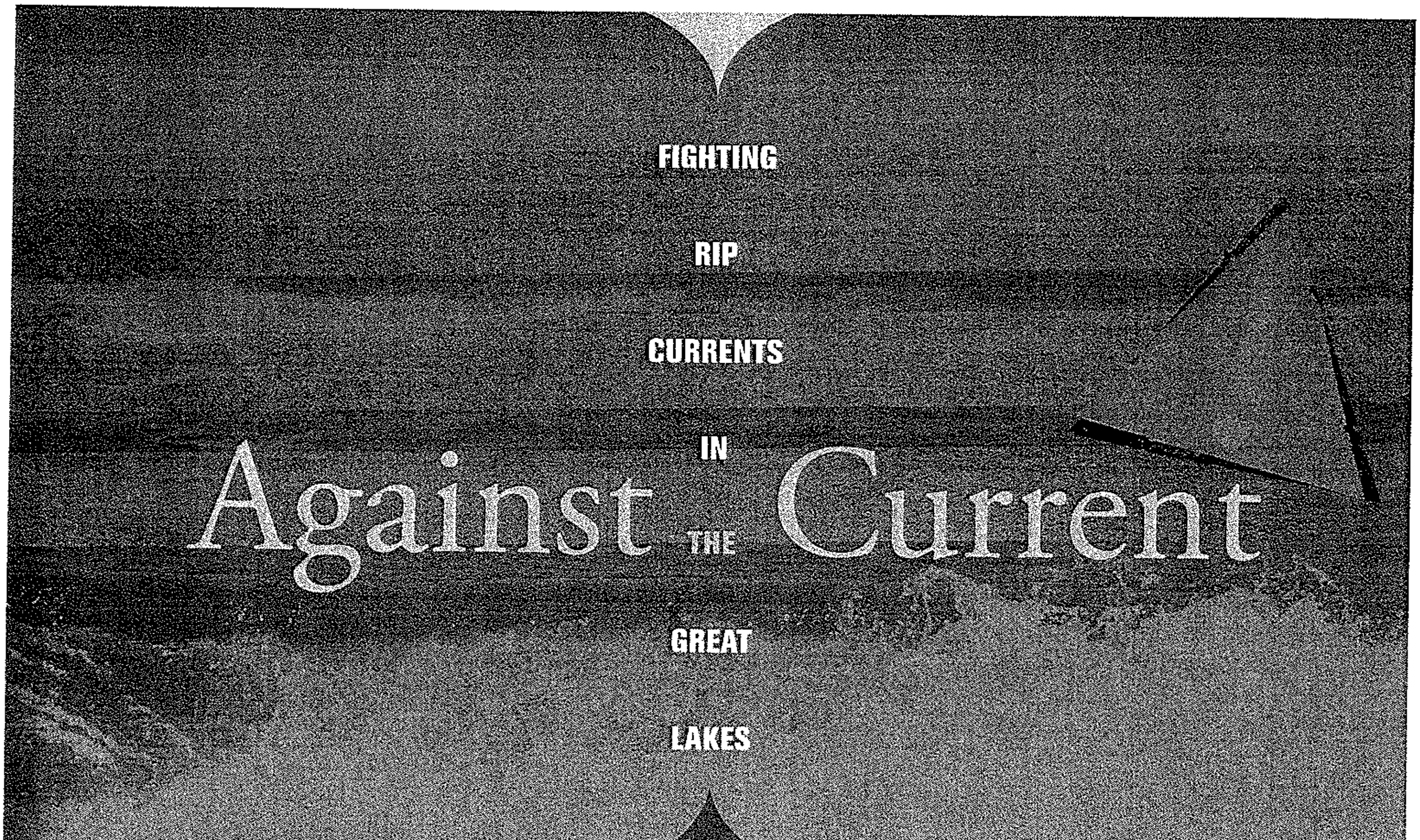


Against the Current

Fighting Rip Currents in the Great Lakes

"When I grew up, it was always 'watch out for the undertow,'" said Toni Brown of Gaylord. "And we didn't know it at the time, but that's pretty much the same thing as rip currents."

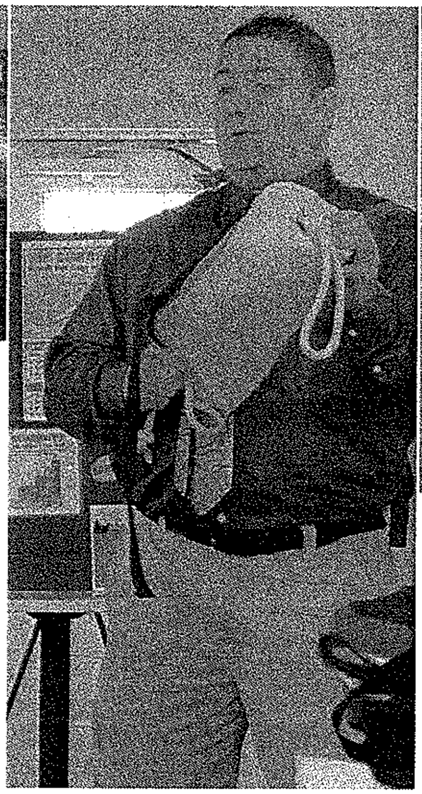
Mrs. Brown was addressing the crowd at the Great Lakes Water Safety Conference held in Gaylord in April. She opened the conference by sharing her personal experience. "This all started July 28, 1998," she said. "That was the day I lost my grandson, Travis."

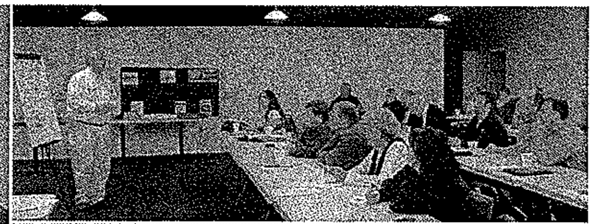
Travis, a 12-year-old from Gaylord, was swimming in Lake Michigan along U.S. Highway 2, west of St. Ignace in the Upper Peninsula. He got caught up in a rip current and drowned. Though Mrs. Brown said she was aware of the "undertow" it wasn't something she connected to rip currents until she learned more about them. "People who don't grow up along the water, even when they're from a few towns over, they don't know what that means," she said.

Mrs. Brown and her husband, Wayne, were instrumental in getting warning signs posted along Lake Michigan and are members of the Mackinac County Water Safety Review Team, which serves to educate the public about swimming hazards in Michigan and the Great Lakes. "I think certain areas do a great job educating swimmers," she said. "I'm real pleased with getting signs posted. But we need to reach out to people who might not be from the area or who might not understand the risk."

Ron Kinnunen, Michigan Sea Grant Upper Peninsula extension educator, assisted partner organizations like safety task force teams with organizing the Great Lakes Water Safety Conference. The conference brought together first responders – fire fighters, lifeguards, police officers and the Coast Guard – as well as local leaders, government officials and emergency response managers.


KURT BYERS






JORDAN KINSLER

BEWARE THE UNDERTOW/ DANGEROUS CURRENTS

Like Mrs. Brown, many growing up along a Michigan coast or near an ocean have probably heard the warning. But the image of the nefarious undertow, pulling a swimmer below the water is an inaccurate one. Rip currents (aka the Great Lakes undertow) pull swimmers away from the shore – not under the water.

"It can feel like something coming from underneath, because in some cases it can sweep the sand out from under you, depending on the strength of the current," said MSG Northwest Extension Educator Mark Breederland while addressing questions at the conference. "It's scary, but it will only pull you out – not under."

The danger strikes when swimmers don't know how to respond, they aren't strong swimmers, they panic – or all of the above. Information on rescues and drownings compiled over the past 10 years indicate there are two groups of people particularly at risk from rip currents, said Dave Guenther, retired National Weather Service specialist on currents. The first group is males aged 18-24 who tend to take more risks such as jumping off piers or other structures into the water (despite warnings not to do so). The other group is older adults attempting to save someone else – a child or grandchild – caught in a rip current. In fact, many of the drownings and rescues cataloged each year are of those who have tried to help. People from outside the immediate area are also at a higher risk for several reasons, one of which is because they are unaware of the danger.

The best way to combat rip current dangers is by: learning more about the anatomy of currents; understanding that the current will take you out, not under; avoiding the water when conditions are ripe for dangerous currents; and knowing how to respond without panicking.

SERIOUS ISSUE

The summer of 2010 brought with it warmer-than-normal water and air temperatures and more people venturing to the Great Lakes to swim. Throughout the swimming season, Great Lakes beaches saw at least 30 drownings – more than any other year in the past decade – and more than 30 additional rescues directly related to rip currents and their close cousin channel currents. However, Guenther commented that awareness of dangerous currents is growing.

Guenther said that when he presented on Great Lakes rip currents at an international rip current conference last year, the other participants were astounded to learn about seven drownings in a three-hour period on Lake Michigan. People knew they occurred in the Great Lakes, he said, but not to that extent.

"The Great Lakes are now being used as an example for other 'inland seas' like the Mediterranean, where rips weren't really taken seriously," he said. "Now they're starting to recognize these currents as a danger."

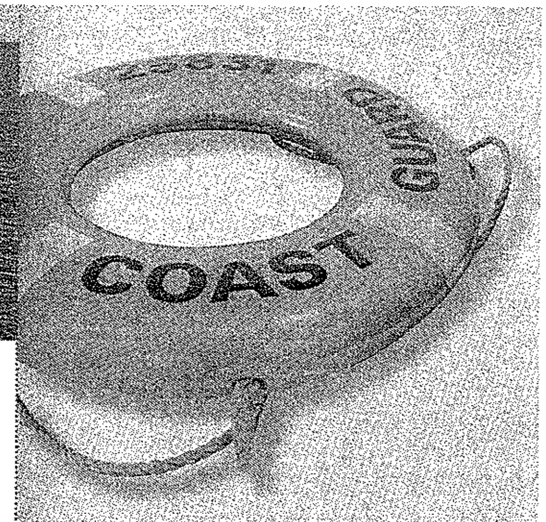
COMMUNITY INVOLVEMENT

Locally, lakeside communities throughout Michigan have been addressing rip currents, but most Great Lakes Water Safety Conference attendees wanted to know: What else can we do? What works? Signs, National Weather Service announcements and rip current warning systems, placemats with information, school curricula, flags, brochures, media coverage, a mascot, awareness events, articles, life-saving stations – they're all tactics organizations throughout the state have used to educate about current dangers. The best methods are likely site specific and will draw upon a combination of solutions.

"I remember after one drowning as a result of rip currents back in 1996," said Eric Smith, vice chair of the Marquette Waterfront Safety Task Force. "It quickly went from a rescue mission to a recovery mission. Several weeks later, I received a letter from the mother of the victim. She said the only thing worse than losing a son is not being able to say goodbye. She thanked us for allowing her to say goodbye. It stuck with me through the years."

That, said Smith, is what drives communities to keep working on the issue. (For more on what Marquette is doing in response to current-related drownings, see the case study on page 5.) Many communities along the Great Lakes have been affected by rescues and drownings related to rip currents, particularly in 2010.

"This isn't the kind of record we want to break," said Kinnunen. "I think by talking about it and bringing everyone together to figure out what will work will give us an edge on educating people and saving lives this summer."



CASE STUDY: Marquette, Michigan

HOW ONE CITY IS BATTLING RIP CURRENTS

Marquette is a town in Michigan's Upper Peninsula (U.P.), on the Lake Superior coast. The town, with about 20,000 people, is the largest in the U.P., home to Northern Michigan University and a large hospital system. It's also a year-round tourist destination known for its access to the water and outdoor recreation opportunities. The Lake Superior beaches found all along the east and north sides of town are a large part of the draw for residents and tourists. There are several city beaches and popular swimming spots that commonly experience rip currents. Some of the popular swim spots also experience a particular type of current called channeling.

For more information see: Tuning in to the Hazards of the Great Lakes (*Upwellings*, June 2010)

In response to several drownings at city beaches, Marquette authorities formed a Waterfront Safety Task Force in August 2010. Eric Smith, vice chair of the task force, said the mission of the group is to create a "culture of waterfront safety." As part of that culture, the task force has been charged with studying waterfront safety from four perspectives: education and awareness; shore and beach support; offshore and afloat support; and emergency preparedness and response.

In order to develop effective solutions, Smith said the task force spent considerable time reading through police reports on drownings and rescues; interviewing professionals in a number of disciplines; cataloging beachfront areas of concern; and researching existing solutions to the problems they identified. To address the various issues they uncovered, the task force recently completed a preliminary report with recommended ways of developing that culture of safety.

THE SEA GRANT CONNECTION

Ron Kinnunen, Upper Peninsula extension educator, works with the city of Marquette leadership and the National Weather Service to research and report on rip currents and channel currents. Kinnunen also helps out extensively with outreach and education in the region. Additionally, he and MSG Extension Educator Mark Breederland and Extension Leader Chuck Pistis helped organize and facilitate the Great Lakes Water Safety Conference in April.

Each year, Michigan Sea Grant extension and communication teams produce educational materials such as the rip current brochure – in both English and Spanish – that identifies what rip currents are and how to escape them. The teams produce other outreach pieces such as *Upwellings* to help bring awareness to the issue. The materials are provided at low cost or no cost to organizations and individuals. MSG has been recognized locally and nationally as a leader in public outreach on this issue.

CONTINUED ON PAGE 8

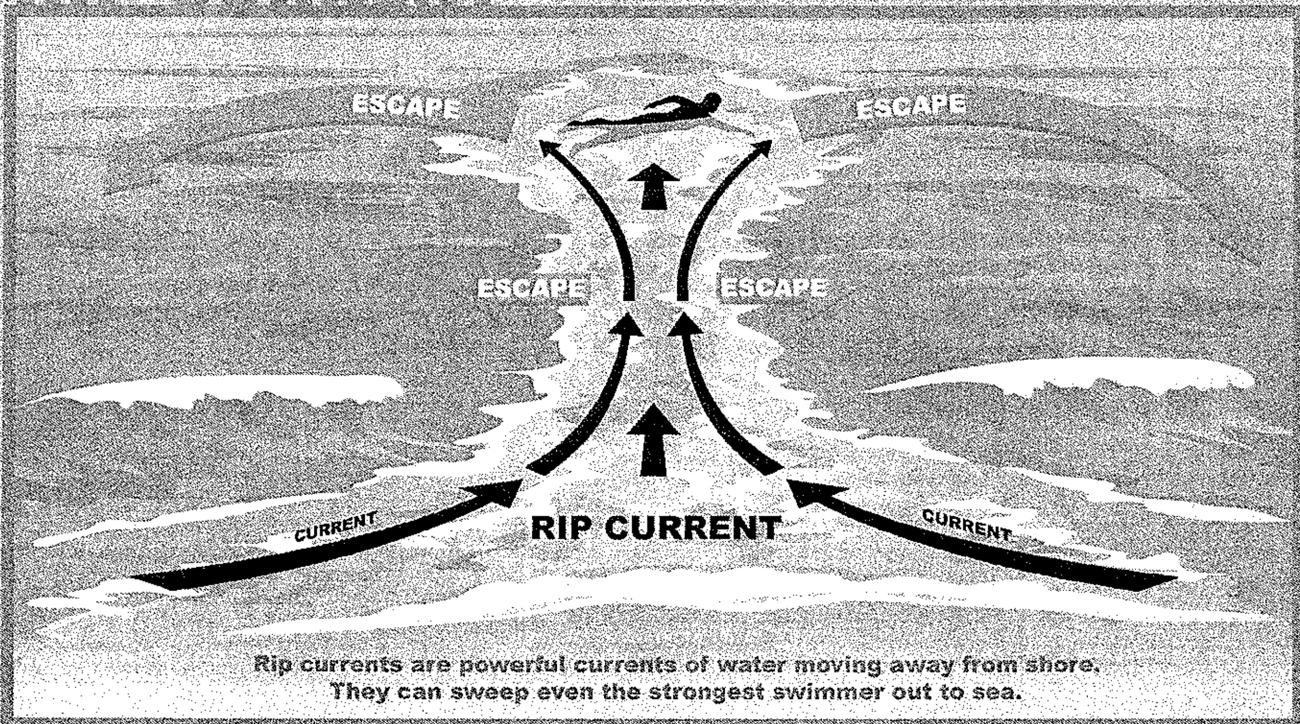
RECOMMENDATIONS IN ACTION

City leadership in Marquette is working with the task force to provide solutions to the common safety issues identified within the report. Among those actions, the city is installing the following for the upcoming swim season:

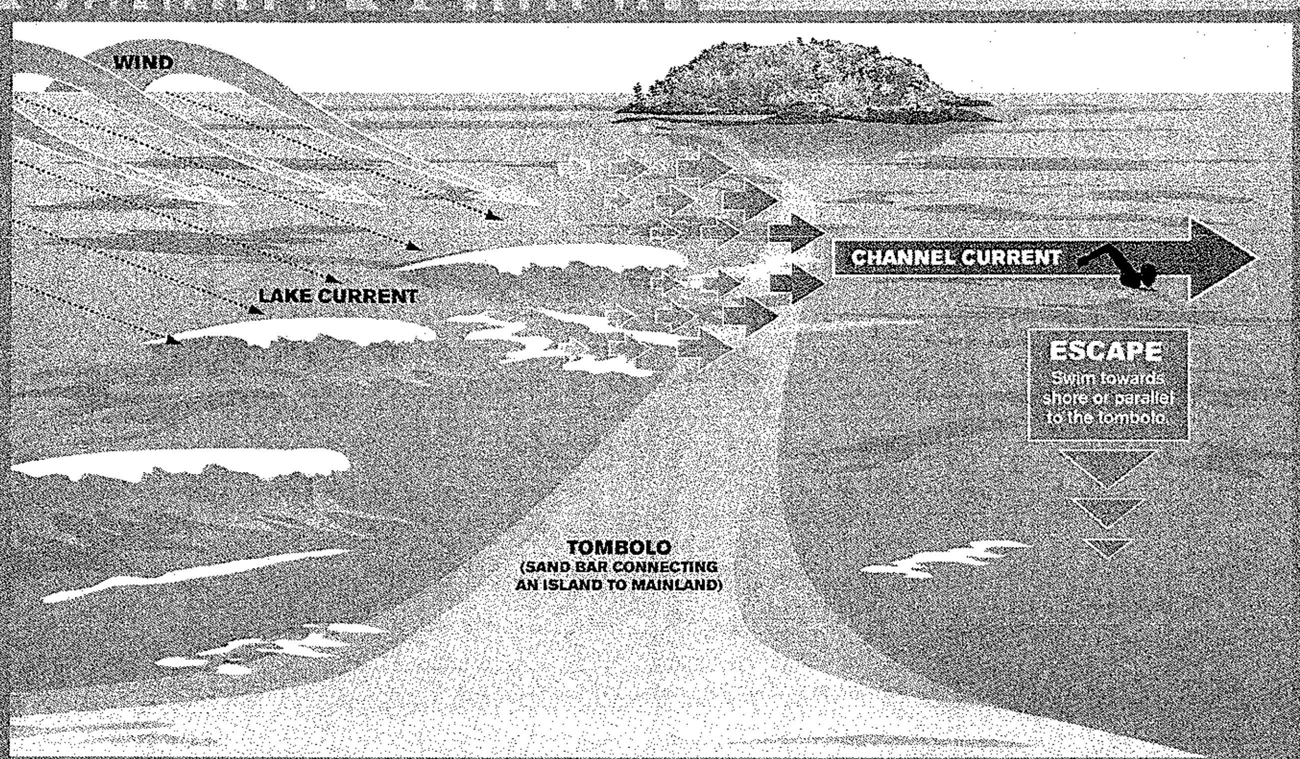
- 6 lifesaving stations that include personal flotation devices, rope, buoys and other lifesaving equipment. When swim season kicks off, the unmanned stations will be set up at Presque Isle, McCarty's Cove, South Beach, Picnic Rocks and two located at the beach area between Picnic Rocks and Hawley Street.
- 3 flotation device loaner stations where beach goers will be able to use flotation devices free of charge. These are found at Presque Isle, McCarty's Cove and South Beach.
- 1 additional flagpole at Middle Bay. The flag will alert people of surf conditions.
- 2 buoys will report conditions that help notify beachgoers of rip currents.
- 1 roaming lifeguard on duty, seven days a week at Black Rocks and the cove south of Black Rocks.

The task force is also forging partnerships to leverage educational reach and to make sure the culture of waterfront safety is comprehensive. For example, the city teamed up with Northern Michigan University to offer Water Safety Week, which features educational outreach and classes like CPR and swim lessons offered for free or low cost.

RIP CURRENT



CHANNEL CURRENT



EXPLANATION:

Rip Currents and Channel Currents

WHAT IS A RIP CURRENT?

Rip currents form when waves break over a sandbar near the shoreline, piling up water between breaking waves and the beach. One of the ways this water returns to sea is to form a rip current, a narrow stream of water moving swiftly away from shore, often perpendicular to the shoreline. The dangerous currents most typically form at low spots or breaks in sandbars, and also near structures such as piers. Rip currents can occur at any beach with breaking waves.

Rip currents can be as narrow as 10 or 20 feet wide, although they may be much wider than that at times. The length of the rip current also varies. Rip currents begin to slow down as they move offshore, beyond the breaking waves. The speed of the currents can vary. Sometimes they are too slow to be considered dangerous. However, under certain wave, wind and beach shape conditions, the speeds can pick up. Rip currents have been measured to exceed 5 mph – faster than you or an Olympic swimmer can swim. Currents measured at 2 mph and faster are considered dangerous.

Rip currents can be found on many beaches every day. Drowning occurs when people pulled offshore are unable to keep themselves afloat and swim to shore. This may be due to any combination of fear, panic, exhaustion or lack of swimming skills. Rip currents are particularly dangerous for weak or non-swimmers.

HOW TO SURVIVE A RIP CURRENT

FLIP-FLOAT-FOLLOW

A new campaign to help people remember how to escape rip currents was recently launched. Flip, Float, Follow are the three actions rip current specialists would like you to keep in mind (like stop, drop and roll). Flip over on your back; float instead of fighting the current; and follow the current until it weakens enough that you can swim out of it.

IN MORE DETAIL:

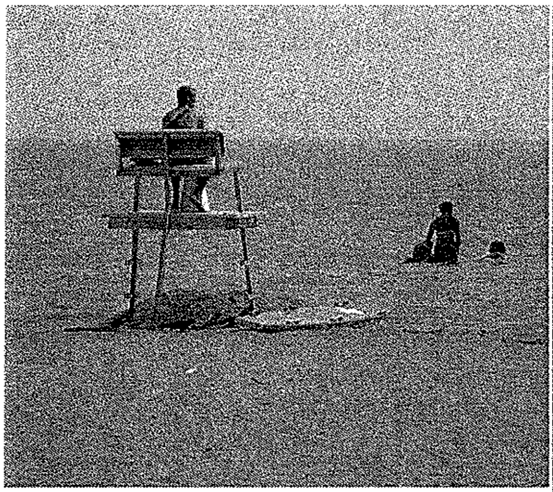
- Do not panic. Remain calm – it sounds simple, but when you realize you're in a current, it may not be your first instinct.
- Ride the current until you can tell which direction it's moving. Swim perpendicular to the current. For rip currents, that's usually parallel to the shore. It can be different for channel currents.
- Don't try to swim against the current. This will exhaust you. Think of the current as a river. You wouldn't try to swim upstream, against the current in a river, would you?
- Tread water or float on your back if you can't figure out which direction the current is flowing or you are tiring.
- Call and wave for help.

BE PREPARED

- Grab a boogie board whenever you swim in one of the Great Lakes.
- Flotation devices are always a good option for kids and adults.
- Note the location of the nearest lifeguard. Stay close by.
- Take your phone to the beach.
- Remember: Flip, Float, Follow.

WHAT IS A CHANNEL CURRENT AND HOW IS IT DIFFERENT?

A channel current is water moving parallel to shore, flowing between the beach and an island. The presence of a tombolo – a partially submerged sandbar connector between the mainland and an offshore island – triggers a convergence of flow that causes the water to speed up as it goes through the area. It's like a river running parallel to shore. The danger is when people are swimming in the area or using the sandbar as a means of transport. When the winds pick up, the waves pick up and will increase the current speeds. When that happens, the swimmer can get pushed off the sandbar or swept into colder water on either side of the sandbar. Swimmers tend to panic and try to get back to the "safety" of the sandbar. The cold water and the current may eventually exhaust them.



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APPLICABLE LESSONS

The report identified several common water safety issues found at Great Lakes beaches. Other communities can use the Marquette guide when considering how to address rip currents at their beaches. The following are summaries of common issues the task force identified.

FROM THE REPORT:

- For people recreating on or in the water, there is no substitute for knowing how to swim. It's also critical that swimmers understand potential hazards. Youth swimming programs conducted by area schools and organizations like the YMCA remain a good way to ensure that as many children as possible learn swimming and water-safety skills.
- Having waterfront safety information available in different formats for residents and visitors is key to helping people make safe, informed choices. Providing usable information is also a primary component in building a culture that keeps waterfront safety a high priority.
- Lifeguards are a high-profile, effective means of monitoring swimming behavior and reducing risky behavior that can lead to tragedy. Guards are the first line of defense in making sure rescues don't turn into recovery missions.
- The availability of beachfront safety equipment is paramount in making sure beach goers have fast access to lifesaving equipment should they see a swimmer in trouble.
- Communications and monitoring technology are key in providing first responders and professionals with the means to reach accident victims quickly and safely.

REGIONAL TASK FORCES

RESPECT THE POWER

The Great Lakes Beach and Pier Safety Task Force formed in response to drownings in Lake Michigan in the Grand Haven area. The task force is made up of many representatives from around the Great Lakes, including Michigan Sea Grant, as well as colleges, federal organizations, education non-profits, other task forces and private citizens.

The group's mission is to bring together resources that help educate about rip currents and beach safety, hoping to prevent drownings in the Great Lakes. They have been successful in placing life rings and other rescue equipment along beaches and piers, installing rip current signs, and developing multi-media educational pieces like interactive cartoons, videos and accessible websites. For example, the task force is the power behind the web portal Respect the Power.

For more information, see:
www.respectthepower.org

MACKINAC COUNTY

Several drownings and numerous near-drownings along a seven-mile segment of northern Lake Michigan shoreline near highway U.S. 2 west of St. Ignace prompted the formation of the Mackinac County Water Safety Review Team (MCWSRT). The group first came together in 1998 and consists of residents, first responders, government representatives and non-profit organizations. The initial tasks were to address drownings along the U.S. 2 shoreline and to work to prevent future drownings.

As part of the safety initiative, the task force has:

- Developed a local brochure on currents
- Distributed the national rip current brochure
- Installed signs along roadside beaches
- Performed school visits with "Coastie" a remote controlled boat-shaped robot
- Produced videos
- Held a logo contest, inviting students to participate
- Installed 10 rescue stations along seven miles of coast
- Numbered the rescue stations and subsequently provided rescue teams with GPS data for each (helping pinpoint rescues)

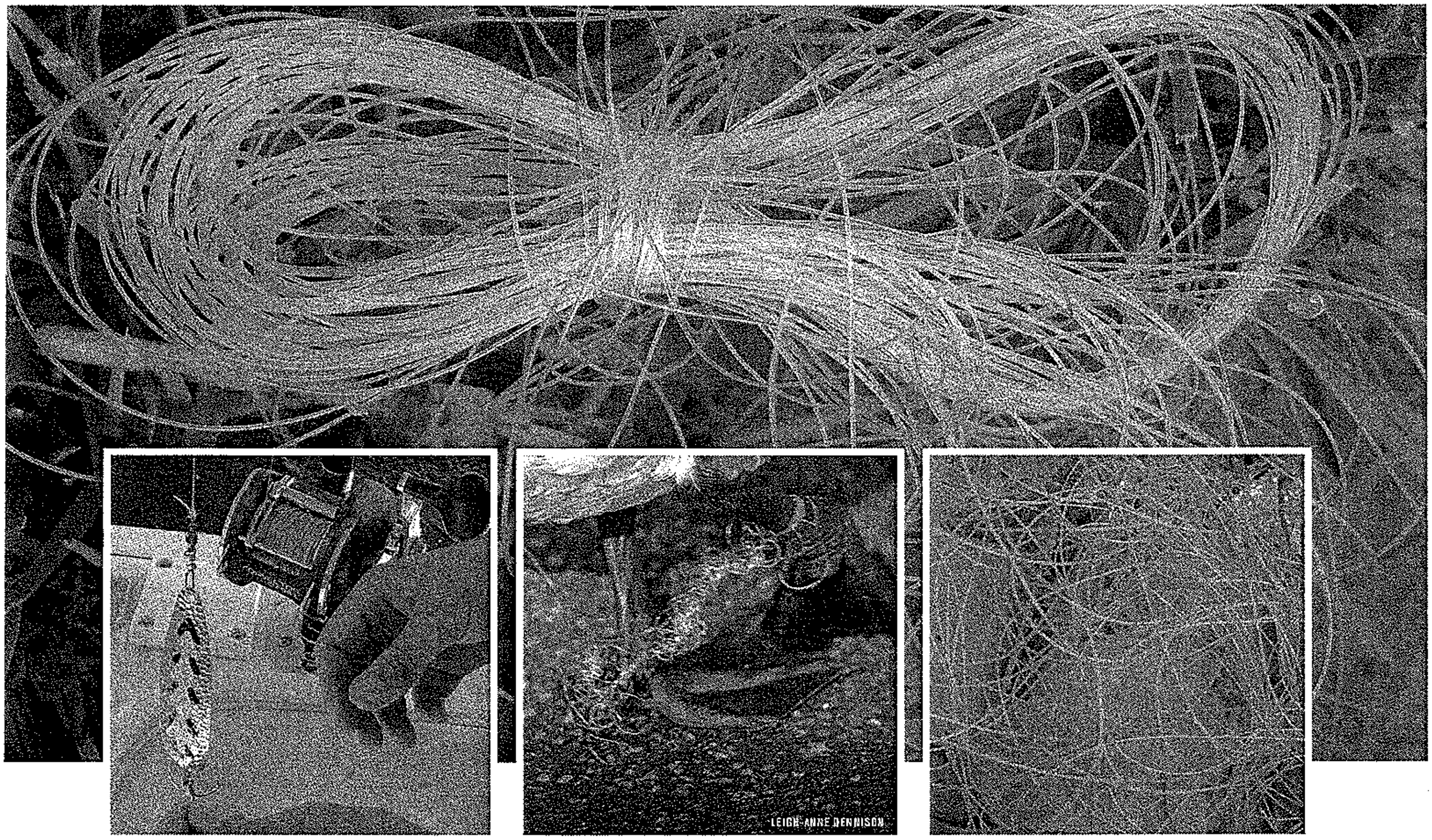
CLEAN MARINA
MICHIGAN

WHAT IS MONOFILAMENT AND WHY SHOULD I RECYCLE IT?

Q & A with Community Outreach Coordinator Amy Samples

Michigan Sea Grant recently launched a monofilament recycling campaign as part of our work toward ensuring that the Great Lakes are well stewarded. As a local sponsor of BoatU.S. Foundation's "Reel In and Recycle" campaign, MSG has acquired recycling bins for distribution to popular fishing areas throughout the state.

Program participants are asked to mount and monitor a PVC recycling bin at a fishing hotspot, periodically empty the bin and ship the monofilament to Berkley Conservation Institute for recycling. But why should someone participate in the program? We asked Amy Samples, Michigan Sea Grant's new community outreach coordinator, for an overview of the issue and more information on how to participate.



LEIGH-ANNE DENNISON

WHAT IS MONOFILAMENT?

Monofilament is a type of fishing line. It is made from a single fiber of plastic. Monofilament is popular with anglers because it is buoyant and because it has an ability to stretch without snapping when there is a fish or something weighty on the line. It is available in a variety of strengths and colors, depending on the user's needs.

HOW DOES IT GET INTO THE ENVIRONMENT?

When monofilament is exposed to heat and sunlight or stretched from repeated use, it weakens, so anglers typically replace their line at regular intervals. You don't want to lose the big one because your line was weak! So when an angler changes out the line and respools the reel, sometimes the old line is left in the bottom of the boat, or can be blown away if left out in the open. Monofilament also enters the Great Lakes system when an angler's hook snags and causes the line to break, by blowing out of trash bins, or when birds mistake the line for nesting material or food and pluck it from trash.

WHY IS IT AN ISSUE?

Typical fishing line takes 500-600 years to breakdown and whoever left it is long gone by then. Both humans and wildlife often realize the consequences. Boat propellers may be jammed by large webs of discarded fishing line, which grow as wind conditions push marine debris ashore. Aquatic wildlife, including fish, turtles and birds become entangled in unintended "nets" of fishing line, leading to strangulation, drowning or even starvation. A turtle in New York was found with 560 feet of heavy-duty monofilament in its gut.

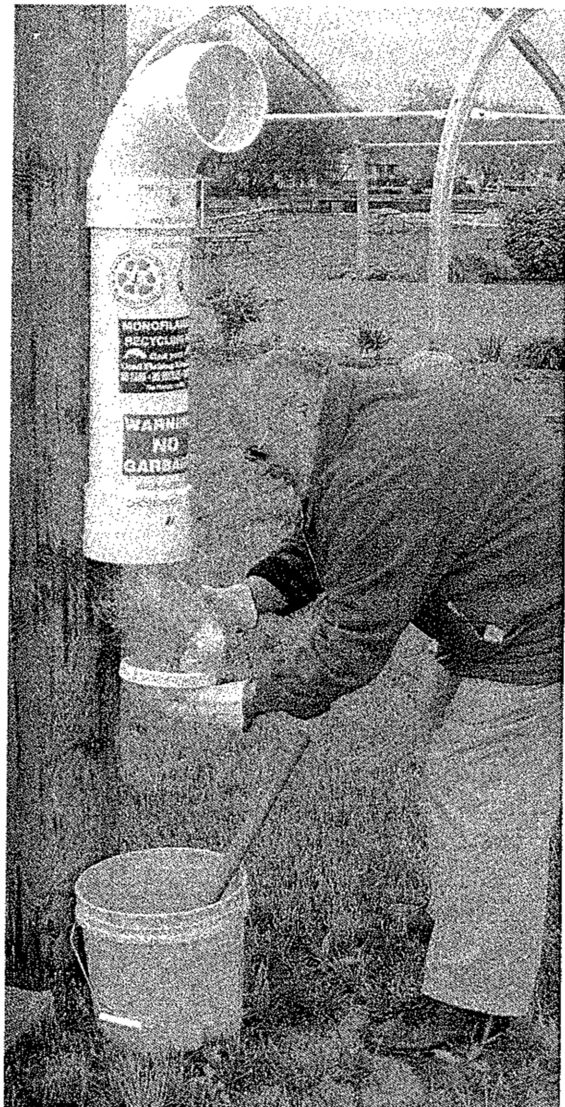
WHAT SHOULD I DO WITH MY USED LINE?

Make sure you discard your monofilament in one of the monofilament recycling bins. If there is not one available, consider asking your marina or pier operator to get one. Michigan Sea Grant is a local sponsor of the BoatU.S. Foundation program and has a limited number of bins available for public use. If you can't find a bin, cut the line into short segments and throw the line into the garbage. Try to find a closed garbage can so the line doesn't blow out once discarded. You can also mail your line directly to recyclers.

WHERE DOES IT GO?

Monofilament line collected at the recycling bins is shipped to Berkley Conservation Institute in Iowa. According to the Berkley Conservation Institute: "Since 1990, the Berkley Conservation Institute, with the help of anglers everywhere, has recycled more than 9 million miles worth of fishing line. That's enough line to fill two reels for every angler in America."

The recycled line is made into something called Fish Hab, an artificial, underwater habitat structure made of monofilament fishing line and other post-consumer materials like plastic milk jugs and soft drink bottles. Once in the water, Fish Hab attracts fish and plant growth by providing structure where none is naturally available – often the case in older or degraded water bodies. This effort is aimed to restore the conditions required to support healthy fish populations.



CASE STUDY: Monofilament Recycling

AN AFTERNOON WITH AN EARLY ADOPTER

Peter McInnes, a self-described retired Coastie – aka Coast Guardsman – still works to ensure his local water body is well looked after. McInnes was an early adopter of monofilament recycling in Michigan and has paved the way for other marinas and fishing locales to follow suit.

McInnes grew up in Detroit, moved to St. Clair Shores in 1969 and worked for Chrysler for 38 years. Since retiring he has been appointed to the St. Clair Shores Waterfront Environmental Committee, voted president-elect of his Kiwanis Club and become a Master Gardener. After learning about monofilament recycling programs in Florida during a Waterfront Environmental Committee meeting, McInnes decided to bring the program to Michigan. Although a different scale of fishing occurs on the shores of Lake St. Clair compared to the marine coastlines of Florida, McInnes perceived value in the program: "The stuff is terrible. It will just sit in scrap heap for hundreds of years – and if a seagull comes along, gets tangled? There, we killed another bird."

"If I pick up one handful, I've made a difference."

McInnes said monofilament cannot be remade into fishing line, but is recycled to make Fish Hab (a trademarked artificial fish habitat product) and tackle boxes – bringing the material back to anglers in a useful form. Since 2007, McInnes has been instrumental in getting three bins installed along the city's shoreline, with a fourth pending.

Stickers credit the bins as a St. Clair Shores Waterfront Environmental Committee project with sponsorship by Shorewood Kiwanis. However, it is volunteers who are responsible for keeping the program running – gathering the line regularly and shipping it off. McInnes has worked with the South Lake High School Team Green (an extracurricular environmental group) and hopes to recruit a local Boy Scout troop to help him manage the bins.

"We try to empty the bins once a month," McInnes explains, "They bring the material to me, I remove hooks and leaders, drop it off at the fishing shop, and they send it on to Berkley [for recycling]."

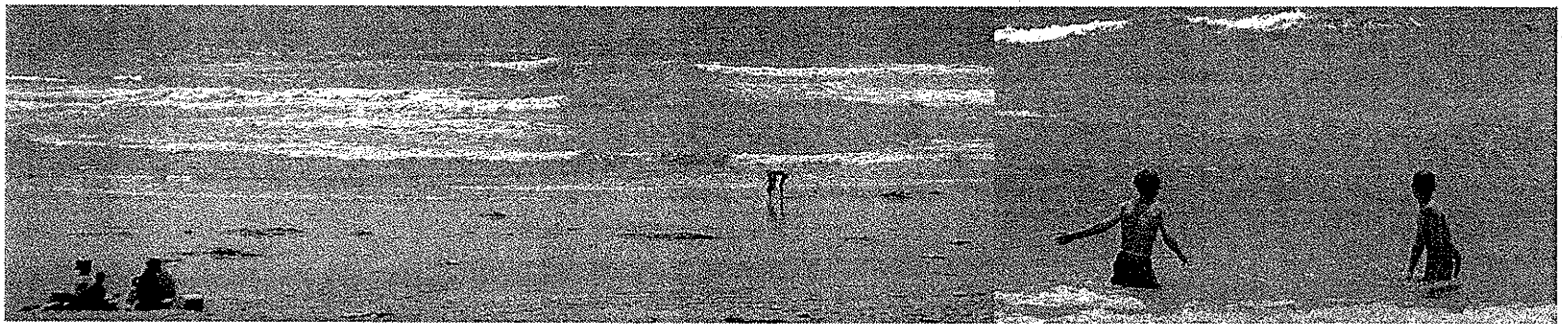
McInnes is also working to expand the program. He built two bins for Harrison Township and is now trying to get additional Michigan Kiwanis Club chapters involved in the recycling effort. He will pitch the idea at the group's annual, statewide meeting in East Lansing later this year. In the hopes of covering more ground, MSG is now distributing bins through a partnership with U.S.Boat.

When asked about the impact of the recycling effort, McInnes recognizes that he's not single-handedly saving the world, but humbly concluded, "If I pick up one handful, I've made a difference."

HOW TO GET A MONOFILAMENT RECYCLING BIN

Please contact Amy Samples at asamples@umich.edu to request a bin for a high-traffic fishing spot in your coastal area. You will need to commit to the program for at least two years and identify a responsible party to collect and ship monofilament from the bin. Bins are limited.

FOR MORE INFORMATION ON THE PROGRAM, SEE: www.miseagrant.umich.edu/cmp/monofilament



FORECASTS – MAKE AN EDUCATED DECISION

The National Weather Service provides weather and water hazard forecasts and warnings throughout the U.S. That information can be used to make an educated decision about swimming at different times in different locations. Here's an example of the tools available:

SURF ZONE FORECAST – Issued daily and provides information on where and when rip currents are most likely to develop – along with why. Wave heights and beach forecasts are also given. They may include information on channel currents. This is the first place you should check when looking for rip current information on specific days and locations.

See: www.ripcurrents.noaa.gov/forecasts.shtml

HAZARDOUS WEATHER OUTLOOK – Provides a one-stop overview on hazardous weather information for different areas. This is issued when hazardous weather is expected within seven days. A moderate or high risk of rip currents will be mentioned when there is a threat. There will not be as much information on the potential currents, but this can be a great resource for areas that are not covered by Surf Zone Forecasts.

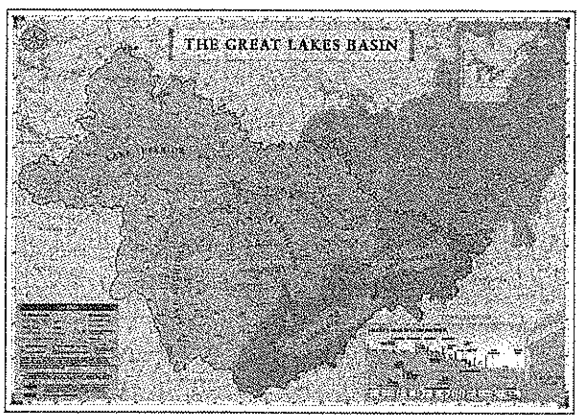
LAKESHORE HAZARD MESSAGE – This web portal details hazards along the lakeshore like flooding or oil spills. It is now being used in conjunction with the Hazardous Weather Outlook to highlight rip current risk, mainly at offices with a Surf Zone Forecast. This is a complementary service that could help provide more information on rip risks in certain location.

Both can be found at: www.weather.gov

PAY ATTENTION AT THE BEACH – If you arrive and there are rip current warning flags raised, consider heading to a different beach or wait for conditions to improve.

To learn more about the science behind dangerous currents, see: www.weather.gov/ripcurrents/

FEATURED PUBLICATIONS



NEW! GREAT LAKES BASIN MAP

Make the 2,212 mile journey from the tip of Lake Superior out to the Atlantic Ocean with this Great Lakes Basin map.

LEARN MORE ABOUT WATERSHEDS

The introduction to *Michigan Watersheds for Teachers, Students and Residents* is now available.

The guide includes watershed diagrams, explanations of watershed concepts and teaching resources that complement the use of the Michigan Watersheds Map.

GREAT LAKES CLIMATE CHANGE

The summer of 2009 was one of Michigan's coldest summers on record. In June of that same year, the U.S. Global Change Research Program published a report stating: "Observations show that warming of the climate is unequivocal." How can scientists say climate is changing if a sweatshirt is needed to stay warm on a July afternoon?

This series of fact sheets outlines the basics of climate and weather, covers changing lake levels and provides an overview of ways communities in the Great Lakes can best prepare for uncertainty in the future.

Go to www.miseagrant.com to order publications and to look for updates on upcoming publications

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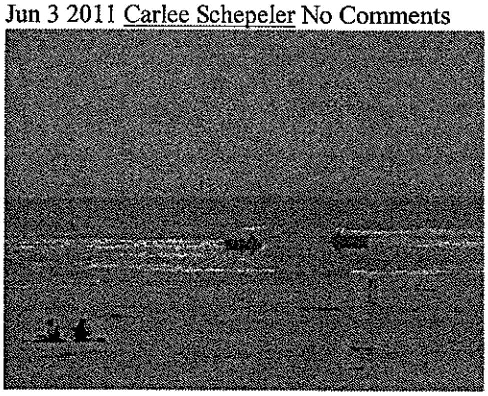
Check out pictures, stay up to date on events like Great Lakes book releases and join the conversation with Michigan Sea Grant on Facebook. Search for Michigan Sea Grant.

GREAT LAKES ECHO

Ocean-force rip currents threaten Great Lakes swimmers; safety effort bridges lifeguard gap

Jun 3 2011 Carlee Schepeler No Comments



The Great Lakes can have ocean-force rip currents. Photo: NOAA.

Benton Harbor High School senior Terrell Burton lost his life to rip currents May 22 in Lake Michigan.

The 19-year-old reportedly dove off the pier at Silver Beach in St. Joseph, Mich., and became the 10^{th} person in 2011 to drown in the Great Lakes.

Such Great Lakes fatalities prompted Dave Benjamin, of Chicago, and Bob Pratt, of East Lansing, Mich., to create the Third Coast Ocean Force, a project to save lives by creating rip current awareness.

A rip current is a strong, usually narrow surface current flowing outward from a shore. It results from the return flow of waves and wind-driven water. In Burton's case, there were only 2-foot waves and 13 mile-per-hour winds.

"A lot of people think they can't drown in lake waves," Benjamin said. "The Great Lakes can have ocean-force rip currents under windy weather conditions."

The group's activity on Facebook is already proving to be effective. Ellen Warren of Oak Creek, Wisc. commented on a link regarding Burton's death:

"Having lived most of my life near Lake Michigan, and swimming [there] many times, I have to admit that I was really unaware of the strength that the lake currents can have," she said on the social media site.

These currents are the primary reason for the 74 reported drowning incidents in the Great Lakes in 2010, said Pratt, a fire marshal in East Lansing, Mich., who is also involved with the Great Lakes Surf Association and Great Lakes Surf Rescue Project.

"The more I learned, the more I realized we don't know anywhere near what you would think we know about rip currents in general and drowning incidents," he said.

In fact, no official agency seems to be counting them. This realization prompted Pratt to begin collecting data independently in

2007.

Some states and counties have different criteria for classifying a drowning, he explained. For example, in Michigan, if an individual dies within 24 hours of a submersion incident, it is considered a drowning, but this categorization criteria isn't consistent across the Great Lakes region.

Two friends reportedly tried to pull Burton to safety, but were unable to pull him out because of the currents, according to WNDU.

An eagle-eye view of a rip current. Photo: NOAA.

"There are hardly any lifeguards at beaches anymore," Pratt said. "We need people who can rescue when others are in danger. Someone has to be the missing link between those in danger and professional rescuers, because it only takes a couple minutes [to drown]."

Surfers in particular are able to safely travel to a dangerous area and assist those in danger. Sunday begins the National Weather Service's annual Rip Current Awareness Week. That day, the Third Coast Ocean Force will launch what they hope to be a series of surfboard rescue technique classes. The first is in St. Joseph, Mich., Benjamin has already been approached to host another class in Frankfurt, Mich. in July.

The Third Coast Ocean Force Facebook group has more than 203 members. The project has created event pages on the social media site – one to spread the word of the June 5 event, and one to alert members of dangerous beach conditions through public service announcements. When rip currents are particularly unsafe, the group sends an update to encourage everyone to be extra cautious at the beach.

The National Oceanic and Atmospheric Administration's daily hazardous weather outlook mentions rip currents if they are of particular concern. Beachgoers should never swim alone, always swim in an area protected by lifeguards, follow the recommendations of lifeguards and always be alert, said a lifeguard on NOAA's website. In addition, NOAA advises that when caught in a rip current, the swimmer should swim parallel to the shore instead of against the current. WZZM has a video that further explains safety methods.

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First Name

Rip Currents in the Great Lakes: An Unfortunate Truth

Guy Meadows[1], Heidi Purcell[1], David Guenther[3], Lorelle Meadows[2], Ronald E. Kinnunen[4] and Gene Clark[5]

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Introduction

The Great Lakes are not characteristic of inland lakes; they are large Inland Seas, with typical dimensions for each lake of the five Great Lakes of over 500 km in length and 150 km in width. Located in the mid-continent interior, strong and rapidly changing wind fields produce correspondingly severe locally generated seas, reaching in extreme conditions, significant wave heights in excess of 7 meters. Many people associate rip currents only with ocean coastlines and are surprised to discover that they do indeed occur with unfortunate regularity along the coastlines of the Great Lakes, (Figure 1). Thus far in 2010 alone, the Great Lakes have experienced 25 rip-related deaths (Documented by National Weather Service). In a recent examination of rip current fatalities over the period of 1994-2007 (Gensini, 2009), the State of Michigan alone stands fourth in the list of greatest number of fatalities for all coastal states in the contiguous United States. Figure 2 displays the locations, and total number for that location, of Great Lakes fatalities due to rip currents that

Figure 1. Rip currents along Grand Sable. Photograph courtesy of Don Rolfson.

have been documented by the National Weather Service (NWS) for the period of 2002-2009. During this period, the Great Lakes Basin experienced an average of 7 rip current fatalities a year. The 25 rip-related deaths in 2010 is the largest number of rip current fatalities recorded for the summer season since NWS first began documenting them in 2002.

Figure 2. Great Lakes rip current fatalities for the period 2002-2009 (as recorded by NWS).

The Great Lakes Basin encompasses over 17,500 km of coastline, almost 2000 km more than the US Atlantic and Pacific coasts combined, much of which is open for tourism. Given this vast amount of coastline and the corresponding large number of visitors, residents and guests, rip currents in the Great Lakes are a phenomenon that should not be overlooked.

Nationally, the general public, as well as the scientific community, has long recognized the significance of rip currents as a coastal hazard on ocean coasts. Over 80% of all surf related rescues are attributable to rip currents with over 20,000 rip-related rescues and approximately 150 fatalities along U.S. beaches in any given year (Lushine, 1991a and 1991b.). It is widely accepted that better forecasting and greater public awareness can mitigate this coastal hazard.

The National Weather Service produces full Surf Zone Forecasts for the Atlantic, Gulf and Pacific coasts, but did not begin issuing Great Lakes Surf Zone Forecasts with rip current risk information until 2006. Within the Great Lakes, several NWS offices are currently testing rip current advisory forecast methods developed in collaboration with the University of Michigan Marine Hydrodynamics Laboratories, based upon wind speed, fetch, duration and other inputs. However, NWS cites a need for better near-shore wave models to help describe the unique characteristics and physical dynamics of the enclosed Great Lake Basin.

Although Great Lakes drownings associated with strong visible cross-shore current structures have been well-documented, very little quantitative data exists to verify the presence of a rip-type flow regime at the time of the incident. A rip current is composed of transient features, requiring immediate data collection response to capture what amounts to "perishable" data. In addition, the unique hydrodynamic conditions which dominate Great Lakes rip current formation require further scientific understanding for the development of a robust regional predictive algorithm.

The following sections of this paper focus on hypothesis-driven, nearshore dynamics to explain the generation of rip currents associated with enclosed basins (such as the Great Lakes). The nearshore dynamics in operation in these basins differ from exposed open oceanic coasts in several important ways.

Rip Current Research

The first scientific observations of rip current circulations were made by (Shepard et al., 1941) off the coast of La Jolla, California. For this site, Shepard and Inman (1950) determined that wave refraction over the offshore topography (i.e. submarine canyons) created strong longshore wave height gradients that led to rip current generation. Other mechanisms for rip current generation were identified through later studies: longshore wave height variation due to standing edge waves (Bowen, 1969; Bowen and Inman, 1969); intersecting wave trains of identical frequency leading to longshore variations in water level (Dalrymple, 1975); nearshore bathymetric variations (Haller et al., 2002); coupled hydrodynamic/morphodynamic systems with variable a longshore bathymetry and hydrodynamics (Hino, 1974).

Scientific observations of rip currents have been hampered by the difficulty in deploying sensitive instrumentation in this harsh flow environment. Despite limited observation sets, detailed examination of currents within rip channels commonly demonstrates pulsations on relatively long timescales. Several explanations exist for this phenomenon. First, rip current pulsations have been shown to be related to infragravity motions on the order of 0.004 to 0.04 Hz (for example, Sonu, 1972; Suhayda, 1974; Wood and Meadows, 1975; Guza and Thornton, 1985; MacMahan et al., 2004a). Second, the mass transport and wave setup produced by the larger waves within a wave group can cause significant "puddling" of water within the surf zone, which returns to the sea via rip channels when the smaller group waves arrive (Munk, 1949; Shepard and Inman, 1950). In addition, longer period motions ($\geq$ 15 mins) of non-gravity waves associated with rip current shear instabilities have been identified as driving rip current pulsations (Smith and Largier, 1995; Brander and Short, 2001; Haller and Dalrymple, 2001). Finally, wave group-induced vortices may also contribute to rip current pulsations (Reniers et al., 2004; MacMahan et al., 2004b).

Within the Great Lakes, Wood and Meadows (1975) made the first field measurements of unsteadiness in longshore currents and observed long period wave induced motions in the 30 to 90 second period ranges. The fluctuations were persistent across the active surf zone and with depth throughout the water column. This quantitative documentation provided details of the longshore feeder flows to periodic rip currents developed through the multiple bar nearshore topography. In 1982, the spatial pattern in Lake Michigan of these wave motions was shown to be observable from space using Synthetic Aperture Radar observations (Meadows et al., 1982).

A secondary aspect of rip current research has focused on the development of the morphological rip channel features through laboratory, field, and numerical studies (see Van Enckevort et al., 2004 and MacMahan et al., 2006 for literature reviews). As mentioned above, in some cases, rip channels are established through interaction of waves with offshore topographic features, such as submarine canyons (Long and Ozkan-Haller, 2005). On many barred beaches, rip channels are expressed as quasi-regularly spaced channels flanked by crescentic bars, and research has focused on the spacing of these channels as related to the incident wave conditions or morphodynamic dimensions. However, this area of research has been unfruitful (for example, Huntley and Short, 1992). More recent studies using time-lapsed video images of the surf zone, although proven as a successful method for data retrieval (Van Enckevort et al., 2004; Holman et al., 2006), have failed to support any causal relationships. Numerical investigations also fall short in providing robust estimates of rip channel spacing (for example, Damgaard et al., 2002). Calvete et al. (2007), through a numerical sensitivity analysis, show that the lack of predictability of rip channel development and spacing is an inherent property of the coastal system, related to the sensitivity of the channel development to the pre-existing bathymetry of the nearshore zone. Thus, a secondary need to fully understand Great Lakes rips is to seek the acquisition of time-sensitive "perishable" data before, during, and after a rip event to determine if any morphodynamic influences of nearshore features may be playing a role in rip current generation. As an example of the importance of this phenomenon, Figure 3 shows a pair of aerial photographs along the same section of Lake Michigan coastline. These two photographs were taken seconds apart as the aircraft proceeded along the shoreline. Hence, the incident wave field is nearly identical in both photographs. The photograph on the left clearly shows a long linear, three bar system in the nearshore region and the photograph on the right shows a complex rip current system in full operation.

Figure 3. Coastal aerial photographs of two adjacent sections of Lake Michigan shoreline along Big Sable Point. The photo on the left shows a long linear, three bar system, while the photo on the right, taken only a few seconds later, as the aircraft progressed, shows a complex rip channel system.

Rip currents have also been observed to vary with tidal elevation on the ocean coast. Although the misnomer of "rip tides" would indicate a relationship with tidal currents, in actuality, the tidal influence is due to the changes in water level accompanying the tidal cycle. Rip currents are tidally modulated such that decreases in tidal elevation increase rip current flows to a relative maximum (Sonu, 1972; Brander and Short, 2001; MacMahan et al., 2005). In the Great Lakes, the astronomical tides are minimal, however, a secondary flow of magnitude and duration similar to ocean coastal tides is the seiche. Seiches are the result of a consistent wind blowing over an enclosed basin, resulting in a mass transport of surface water towards the downwind coast (Figure 4) and resultant increase in water level. When the wind ultimately decreases or shifts,

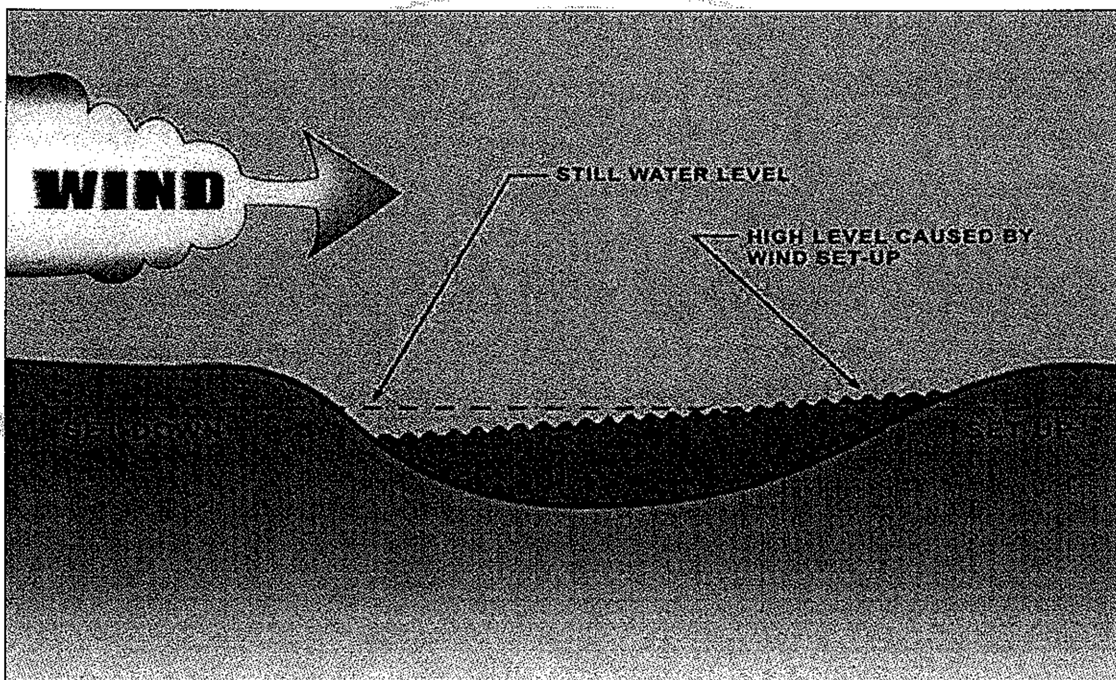

Figure 4. A seiche caused by water buildup due to wind stress or pressure gradient in an enclosed basin (modified from Great Lakes Atlas: http://www.epa.gov/glnpo/atlas/index.html).

this buildup of water is free to flow back, resulting in a complex rotational wave within the basin, not dissimilar from a tidal bulge along an exposed ocean coastline. For example seiching (wind tides) both contribute excess water to the nearshore zone and can significantly change wave elevation over relatively short time periods.

Excessive water level variations are also common to the Great Lakes Basin on a variety of time scales not seen on open ocean coasts. Water level variations on the order of 0.3 meters occur seasonally with variations as large as 0.5 meters annually and extremes approaching 2 meters on decadal time scales. These longer term fluctuations change beach and nearshore slopes, cause migration of semi-permanent sand bars and alter the nearshore sediment supply (Meadows et. al., 1997). Since the waters that fill the Great Lakes are primarily the result of evaporation and precipitation over the basin, even the incident wave climate varies with the frequency and intensity of the storms on these same decadal time scales. Figure 5, depicts a representative section of the long term water level record for Lake Michigan and Huron from 1918 through 2002. This water level history clearly demonstrates the multiple scales of Great lakes water elevation variation.

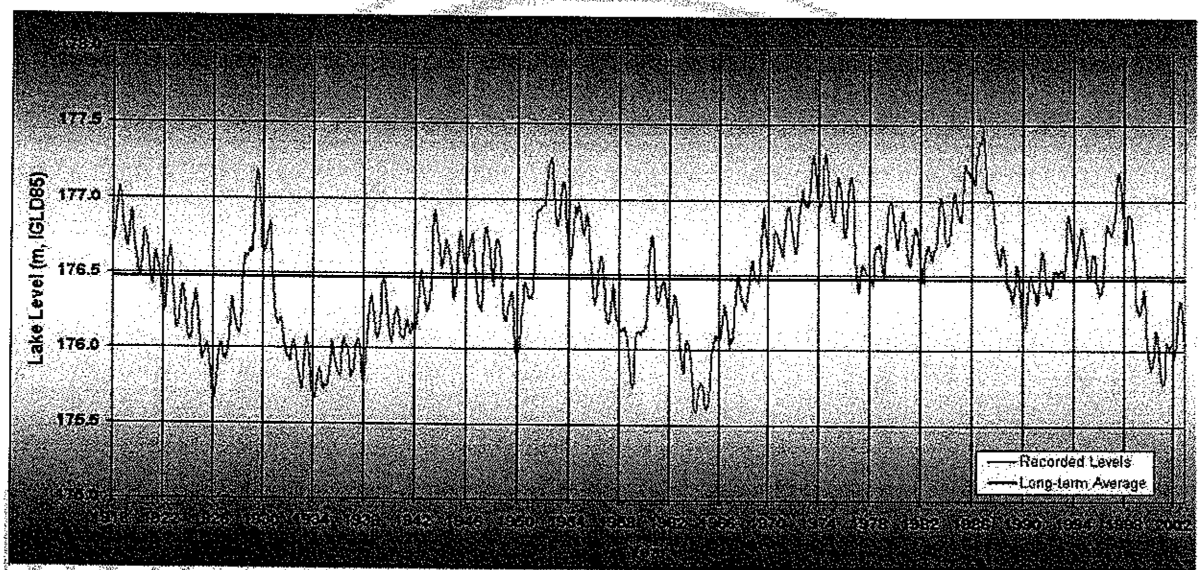

Figure 5. A representative section of the Lake Michigan-Huron water level record (1918 – 2002) from NOAA.

Finally, the wind generated wave systems of these enclosed basins are primary locally generated (resulting from the cyclones present over the basins themselves). Locally generated seas are complex, unsorted, steep, widely distributed in direction, and often accompanied by strong longshore components of wind. All of these factors combine to contribute to strong and difficult-to-predict nearshore circulations along the coastlines of the Great lakes.

Enclosed Basin Nearshore Dynamics

Although the Great Lakes are similar to the ocean in many ways, there are pointed differences between the two that make rip current generation in the Great Lakes somewhat unique. As previously mentioned, the changing water levels (on many time scales) of the Great Lakes affect the location and movement of near shore sandbars, in turn affecting the location and formation of rip current channels. It has been observed that increased wind and higher wave energy precedes an increase in long term water levels (Meadows et al., 1997), which may set the "bathymetric stage" for increased rip current frequency. In general, these conditions lead to a steeper, more mobile nearshore zone. Also, the Great Lakes Basin are enclosed, which creates the unique condition mentioned earlier, the seiche. Although common to all of the Great Lakes, the most extreme seiches occur in Lake Erie (relatively shallow basin, oriented east-west into the prevailing wind) with recorded elevation differences between Toledo, Ohio and Buffalo, New York of 4.9 meters. These seiches oscillate in the longitudinal mode with a period of approximately 16 hours. Seiching both contributes excess water to the nearshore zone and can significantly change water elevation over relatively short time periods. For example, the series of seven drownings along the southeast shoreline of Lake Michigan on July 4th of 2003 were associated with a moderate to strong seiche of the basin (Guenther, 2003). During this single event, seven rip-related drownings were reported within a three-hour period along a concentrated three mile section of State Park beach between 16:30 and 19:30 Z. Fortuitously the location of these tragic events is ringed by NOAA / National Ocean Service's (NOS) water level gauges. The location of these gauging stations is presented in Figure 6, with corresponding water level records provided in Figure 7.

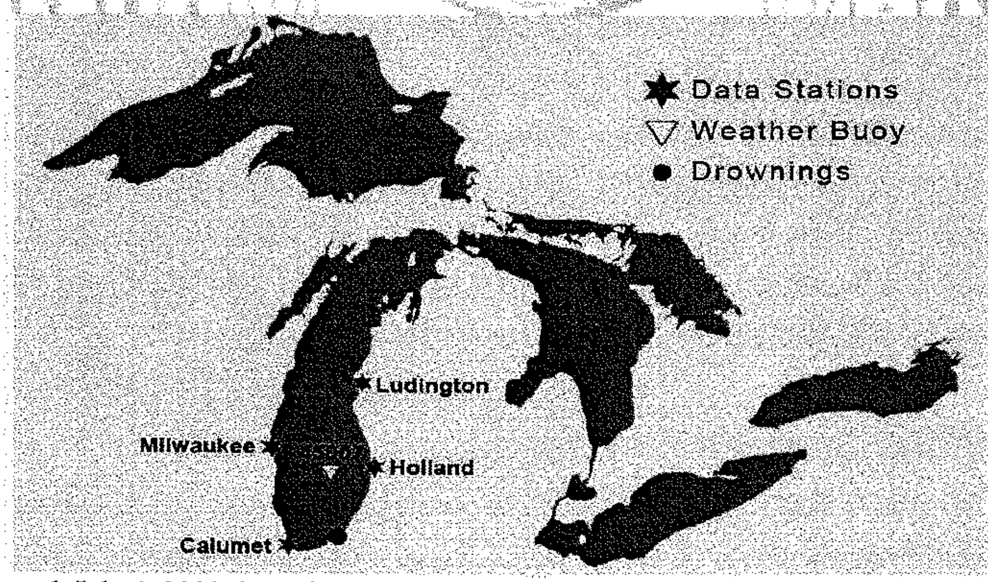

Figure 6. July 4, 2003 drowning event location in Lake Michigan, showing surrounding data stations.

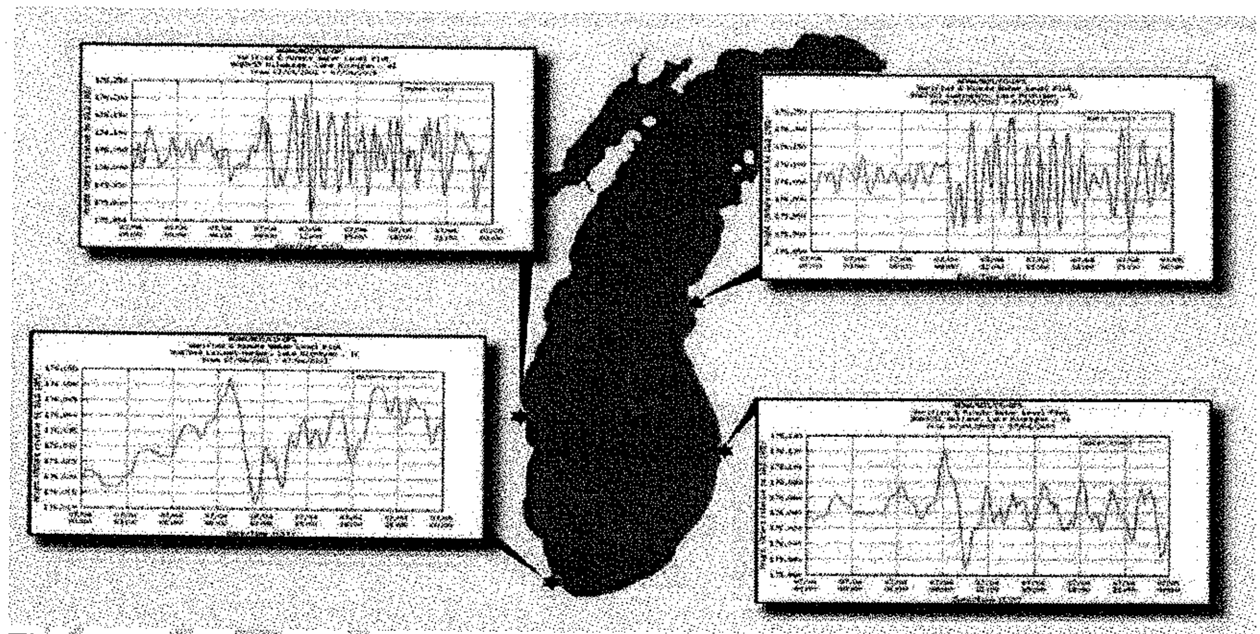

Figure 7. Water level records for each Lake Michigan NOAA, for recording sites noted in Figure 6.

It is evident from these records that both a transverse and longitudinal seiche were present in southern Lake Michigan at the time of the fatalities. These seiche modes were excited by the passage of an intense squall line and corresponding wind shift.

In 2002 four men drowned in a strong rip current off Nickel Plate Beach in Huron, Ohio. Once again, the records from the NOS gauging stations indicate that a seiche had occurred spanning the times of the drowning. The two records, shown in Figure 8, are from NOS stations at Marblehead, OH and Sturgeon Point, New York.

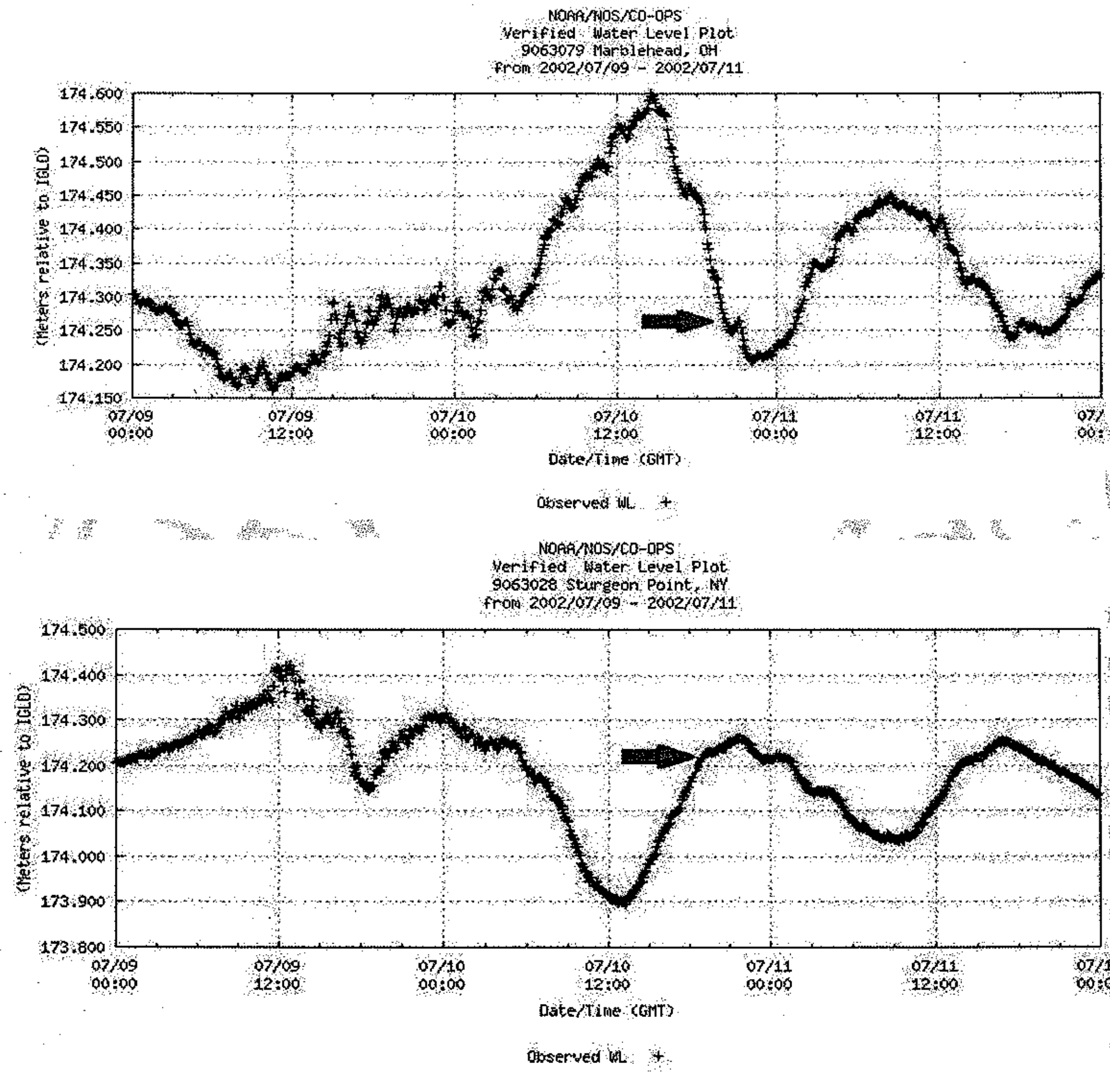

Figure 8. NOS water level records for Lake Erie for July 9-11, 2002. The arrow points to the water level at the time of the rip current drownings.

Thus, it is hypothesized that long period dynamics in the Great Lakes, especially those of seiche mode frequency, (with periods on the order of hours) may contribute to the generation of rip currents.

A second important difference between Great Lakes coastlines and that of exposed ocean coastal regions lies with the incident wave field. The dimensions of the Great Lakes Basin are comparable in spatial scale to the atmospheric low and high pressure system that traverse the region. This produces an incident wave climate composed primarily of locally-generated fetch limited seas. Locally generated seas are complex, with unsorted, steep waves that are widely distributed in direction, and often accompanied by a strong longshore wind component. This is in stark contrast to the conventional wisdom of rip current generation, requiring a well organized wave field to produce a correspondingly well organized nearshore circulation. All of these factors contribute to strong and difficult-to-predict Great Lakes nearshore circulations.

Furthermore, in the fall, strong air/sea temperature differences develop as the Lakes warm. Cold outbreaks of Canadian polar air drive large and rapid wave growth, resulting in the infamous November storms of the Great Lakes ("the Gales of November"). In a brief review of notable major Great Lakes shipwrecks, it is observed that:

- **M/V Edund Fitzgerrald** **29 crew/29 lost** **November 10, 1975**
- **M/V Carl D. Bradley** **35 crew/33 lost** **November 18, 1958**
- **Great Storm of 1913** **251 lost from 12 ships** **November 7-11.**

Obviously, the combination of warm Lake temperature coupled with strong outbreaks of wind in November, combine to produce very dangerous Great Lakes wave conditions. Although still present, this threat is less in the late summer months (August – September) when the beaches are still very active. Under these unstable atmospheric conditions, wave growth is alarmingly fast, often catching bathers, surfers and first responders off guard.

A vivid example of this phenomonon is provided by the dedicated work of the Great Lakes Environmental Research Laboratoy (GLERL) of NOAA in numerical wind and wave forecasting. The Great Lakes Coastal Forecasting System (http://www.glerl.noaa.gov/res/glcfs/) provides twice daily predictions of wind, wave, circulation, temperature structure and water level elevation for all five of the Great Lakes. Figures 9 and 10 provide an example of rapid and severe wave growth for a late year (November), large air/sea temperature difference, wind outbreak as described above. Note, significant wave heights are presented in feet.

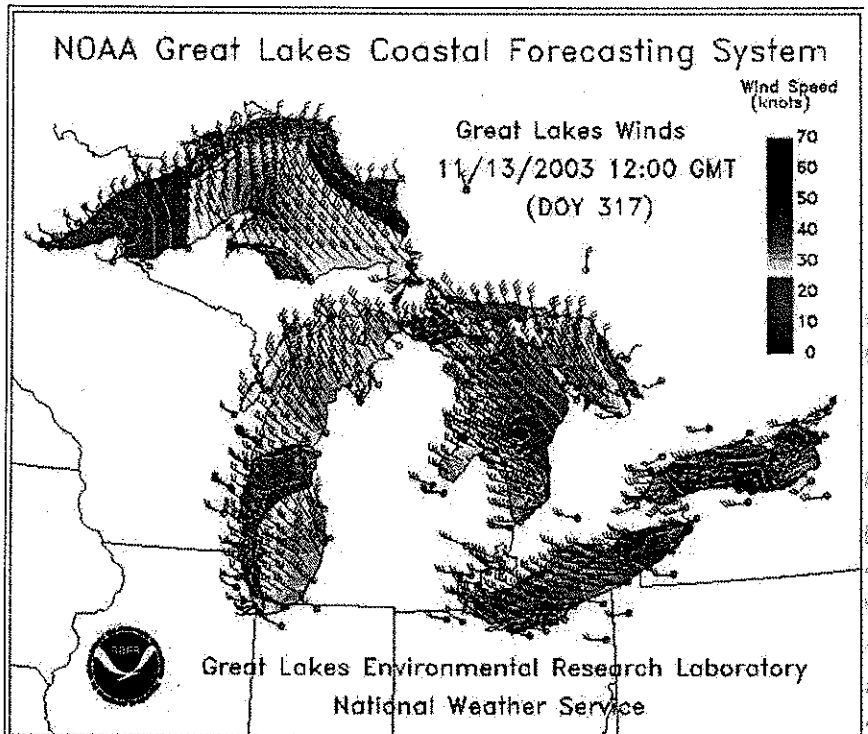

Figure 9. Strong, late season, outbreak of Canadian air over the Great Lakes Basin

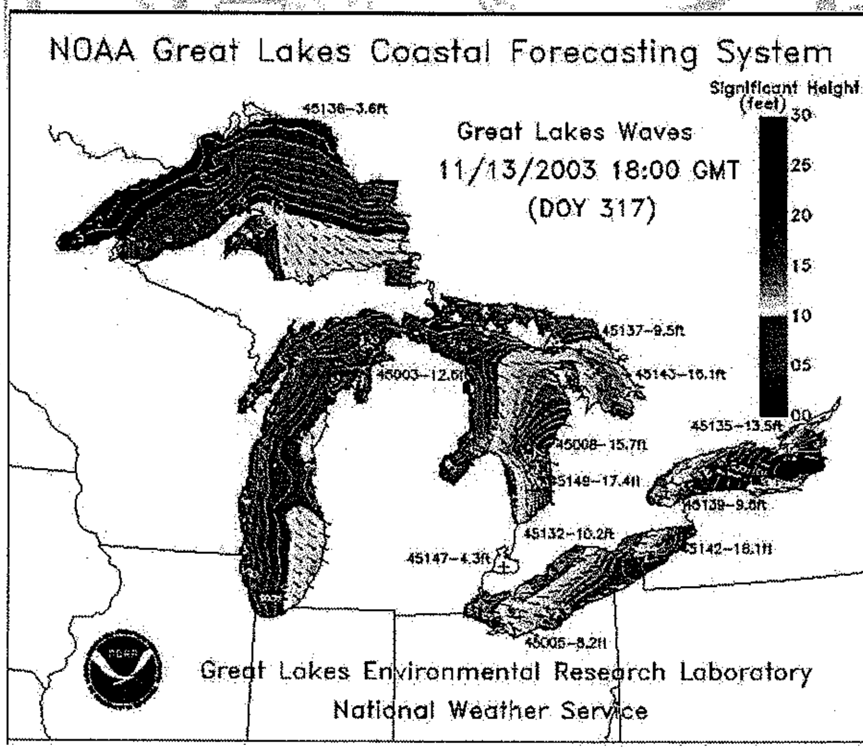

Figure 10. Resulting Great Lakes wave field (Significant wave height in feet).

Great Lakes Rip Current Forecasts

The dynamics of the Great Lakes enclosed basin and the locally generated seas provide many difficulties for the forecasting of rip currents. In 2006, the NWS Great Lakes offices began issuing Surf Zone Forecasts which included rip current risk information. Forecasting Great Lakes rip currents is a three step process. First, the forecaster collects data on the observed conditions. The Great Lakes are surrounded by a comprehensive network of observing platforms where ground truth information can be obtained to verify forecasts and update as needed. These include but are not limited to:

1. Buoys – The United States National Data Buoy Center (NDBC), Environment Canada, and most recently added, the Great Lakes Observing System (GLOS) coastal monitoring network with directional wave capability, all maintain buoys on the Great Lakes. These buoys provide wave heights, wind speed and directions, and periods of the waves. The GLOS buoys and a few of the NDBC buoys also provide wave directional information. The NDBC and Environment Canada buoys are located mid lake, while the GLOS buoys are located along the Great Lakes' coasts. All buoys give valuable real time data.
2. NOS Gauges – National Ocean Services maintains a network of 54 tide gauges around the Great Lakes, which measures the lake levels at 6 minute intervals as well as providing wind data, air temperature, relative humidity, and barometric pressure. These are particularly helpful in monitoring for seiches.
3. Doppler Radar - The National Weather Service and Environment Canada blanket the Great Lakes with Doppler radar coverage, providing real time precipitation and wind data aloft.
4. Ship Observations/Volunteer Ship Observations - Numerous boats and ships on the Great Lakes volunteer to submit observations at regular intervals as they travel the Great Lakes. They provide weather, temperature, wind data, and wave information.
5. Nearshore Automated Observation Platforms - Numerous automated aviation and marine observing stations are also available near shore within a few miles of the lakes.
6. Satellite Information - Satellites provide sky cover, ice conditions and temperature profiles over the lake.

7. Rawinsonde Stations - Numerous rawinsonde stations are in close proximity to the Great Lakes and provide wind and temperature profiles of the air mass over the lakes. Each rawinsonde station takes readings twice a day.

Great Lakes Rip Current Checklist

I. Wave Factors

Height	Degrees from normal 0 to 30	Degrees from normal 30 to 70
1 ft	0.5	0.0
2 ft	1.0	0.5
3-4 ft	2.0	1.0
5-7 ft	3.0	1.5
8-10 ft	4.0	2.0
> 10 ft	5.0	3.0

Wave factor ______

II. Wind Speed

Speed	points
0- 5 kt	0.5
6- 8 kt	1.0
9- 11 kt	1.5
12- 14 kt	2.0
15- 17 kt	3.0
18- 20 kt	4.0
> 20 kt	5.0

Wind factor ______

III. Wave Period in Seconds

5-6 sec	0.5
7-8 sec	1.0
9-10 sec	2.0
> 10 sec	3.0

Period factor ______

IV. Lake level vs normal

above	> 3 in	- 0.5
	normal	0.0
below	-6 to -11 in	1.0
	> -11 in	2.0

Lake level factor ______

total ______

low risk < 4 moderate risk = 4 to 7 high risk > 7

Figure 11. Great Lakes Rip Currents Checklist

After the observed data is collected, forecasts of the wind speed and directions over the Great Lakes are made by the operational forecasters at each NWS forecast office in the Great Lakes region. The wind forecasts are then used to predict the wind wave characteristics on the Great Lakes (including wave height, period and direction).

Once the wind and wave forecasts are completed, forecasters then determine the rip current risk for their area by applying the Great Lakes Rip Current Checklist (GLRCC) (Figure 11). This GLRCC was first developed for the Great Lakes by modifying the East Central Florida Lushine Rip Current Scale (ECFL LURCS) (Engle, et al., 2002) and the Lushine Rip Current Scale (LURCS) (Lushine, 1991) using parameters unique to the Great Lakes. This checklist works well for the long fetch parts of the Great Lakes with sandy beaches. For the breakwaters and groins, forecasters follow the general assumption that onshore wind will create a flow that will pile water onshore that will then flow parallel to shore. That flow condition combined with waves of 0.6 m or higher will produce a moderate or high risk of rip currents. The forecasters will adjust their criteria based on feedback from local users at specific beaches and around specific coastal engineering structures (e.g. breakwaters, harbor jetties, etc.).

After the rip current risk has been assessed, the Great Lakes office disseminates this and other relevant information using the Advanced Weather Interactive Processing System (AWIPS)

SURF ZONE FORECAST
NATIONAL WEATHER SERVICE MARQUETTE MI
354 AM EDT THU JUL 1 2010

MIZ005- MIZ006-012115-
MARQUETTE/ALGER-
354 AM EDT THU JUL 1 2010

.TODAY...
SKY/WEATHER...............MOSTLY SUNNY (30-40 PERCENT).
MAX TEMPERATURE.....78-83.
BEACH WINDS...............NORTH WINDS 10 TO 15 MPH.
SURF...............................2 FEET OR LESS.
WATER TEMPERATURE..53 DEGREES.
RIP CURRENT RISK.........LOW...HOWEVER...STRONG CURRENTS CAN OCCUR NEAR PIERS AND JETTIES. ALWAYS HAVE FLOATATION DEVICE WITH YOU IN THE WATER.

Figure 12. Example of Surf Zone Forecasts

(Glahn, et al. 2003) which routes the forecasts through the family of services network to the media and through the Internet to all other interested users. Products, including the Surf Forecast (Figure 12) are produced by six offices throughout the Great Lakes that seem to have the largest threat of rip currents.

The Surf Forecast provides additional information on air and lake temperatures, wind and wave conditions, rip current risk and other relevant information for end users. Other lake shore offices that do not experience a serious rip current threat in their county warning area, have opted to produce Lakeshore Hazard Messages whenever conditions for a moderate or higher risk of rip currents exists in their nearshore area of responsibility. All offices also provide information in the Hazard Weather Outlooks whenever there is a moderate or high risk of rip currents.

Conclusions

The Great Lakes possess both the breadth and power to develop the dynamics necessary for the production of rip currents, which pose a significant threat to the recreational community.

To date, most rip current research has been conducted in the ocean environment, in order to best serve the Great Lakes region, the enclosed basin dynamics unique to the Great Lakes should be investigated more thoroughly. Time sensitive "perishable" data needs to be collected before, during and after documented rip current events to determine if any morphodynamic influences play a role in rip current generation. Seiches (wind tides), which have been recorded in conjunction with a number of documented rip current drownings, leading to hypothesis that the long period dynamics of these seiches may contribute to the generation of rip currents, requires further study. The various scales of changing water levels, and locally generated seas, must be further examined in order to better determine how these dynamics influence the formation and correspondingly the forecasts of rip currents on the Great Lakes. Using the data collected from this research, The Great Lakes sector of NWS will be able to refine their rip current forecasting capabilities, making Great Lakes beaches safer and more attractive to residents and tourists alike.

References

Bowen, A.J., (1969). Rip currents: 1. Theoretical investigations, *Journal of Geophysical Research, 74*(23), 5467-5478.

Bowen, A.J., & D.L. Inman, (1969). Rip Currents: 2. Laboratory and field observations, *Journal of Geophysical Research, 74*(23), 5479-5490.

Brander, R.W., & A.D. Short, (2001). Morphydynamics of a large-scale rip current system at Muriwai Beach, New Zealand, *Marine Geology, 165*, 27-39.

Calvete, D., G. Coco, A. Falques, & N. Dodd, (2007). (Un)predictability in rip channel systems, *Geophysical Research Letters, 34*, L05605, doi:10.1029/2006GL028162.

Dalrymple, R.A., (1975). A mechanism for rip current generation on an open coast, *Journal of Geophysical Research, 80*, 3485-3487.

Damgaard, J., N. Dodd, L. Hall, & T. Chesher, (2002). Morphydynamic modeling of rip channel growth, *Coastal Engineering, 45*, 199-221.

Engle, J., J. MacMahan, R. J. Thieke, D. M. Hanes, & R. G. Dean, (2002). Formulation of a rip current predictive index using rescue data. *Proceedings National Conference on Beach Preservation Technology*, Florida Shore and Beach Preservations Association, Biloxi. MS.

Gensini, V., & W. Ashley, (2009). An examination of rip current fatalities in the United States. *Natural Hazards, 54*(1), 159-175.

Glahn, H. R., & D. P. Ruth, (2003). The New Digital Forecast Database of the National Weather Service. *Bulletin of the American Meteorological Society, 84* (2), 195-202.

Guenther, D., (2003). Rip current case study 3, 4 July 2003, *Marquette Michigan National Weather Service Office Report*, (pp.10).

Guza, R.T., & E.B. Thornton, (1985). Observations of surf beat, *Journal of Geophysical Research, 90*, 3161-3171.

Haller, M.C., & R.A. Dalrymple, (2001). Rip current instabilities, *Journal of Fluid Mechanics, 433*, 161-192.

Haller, M.C., R.A. Dalrymple, & I.A. Svendsen, (2002). Experimental study of nearshore dynamics on a barred beach with rip channels, *Journal of Geophysical Research, 107*(C6), 3061, doi:10.1029/2001JC000955.

Hino, M., (1974). Theory on formation of rip-current and cuspidal coast, *Proceedings of Coastal Engineering 1974*, (pp. 901-919), Reston, VA: American Society of Civil Engineering.

Holman, R.A., G. Symonds, E.B. Thornton, & R. Ranasinghe (2006). Rip spacing and persistence on an embayed beach, *Journal of Geophysical Research, 111*, C01006, doi:10.1029/2005/JC002965.

Lascody, R.L., (1998). East Central Florida rip current program. *National Weather Service Digest, 22*(2), 25-30.

Long, J.W., & H.T. Özkan-Haller, (2005). Offshore controls on nearshore rip currents, *Journal of Geophysical Research, 110*, C12007, doi:10.1029/2005JC003018.

Lushine, J.B., (1991). A Study of rip current drowning and related weather factors. *National Weather Digest, 16*, 13-19.

Lushine. J.B., (2005). Rip Current Formation and Forecasting. Presentation at Beach Safety Educational Workshop, March 2005. At Florida Fish & Wildlife Research Institute Auditorium, St. Petersburg, FL

MacMahan, J.H., E.B. Thornton, & J.H.M. Reniers, (2006). Rip current review, *Coastal Engineering, 53*, 191-208.

MacMahan, J.H., J.H.M. Reniers, E.B. Thornton, & T.P Stanton (2004a). Infragravity rip current pulsations, *Journal of Geophysical Research, 109*, C07004, doi:10.1029/2003JC002083.

MacMahan, J.H., J.H.M. Reniers, E.B. Thornton, & T.P Stanton (2004b). Surf zone eddies coupled with rip current morphology, *Journal of Geophysical Research, 109*, C01003, doi:10.1029/2003JC002068.

Meadows, G.A., L.A. Meadows, W.L. Wood, J.M. Hubertz, & M. Perlin, (1997). The Relationship Between Great Lakes Water Levels, Wave Energies and Shoreline Damage, *Bulletin of the American Meteorological Society, 78* (4), 675-683.

Meadows, G.A., R.A. Shuchman & J.D. Lyden, (1982). An Analysis of Remotely Sensed Long-Period Wave Motions, *Journal of Geophysical Research, 87* (C8), 5731-5740.

Munk, W.H., (1949). Surf beats, *EOS: Transactions of the American Geophysical Union, 30*(6), 849-854.

NOAA, (2005). New Priorities for the 21st Century – NOAA's Strategic Plan: Updated for FY2006-FY2011. US department of Commerce, pp 1-24.

Reniers, J.H.M., J.A. Roelvink, & E.B. Thornton, (2004). Morphydynamic modeling of an embayed beach under wave group forcing, *Journal of Geophysical Research, 109*, C01030, doi:10.1029/2002JC001586.

Shepard, F.P., & D.L. Inman, (1950). Nearshore water circulation related to bottom topography and wave refraction, *EOS: Transactions of the American Geophysical Union, 31*(2), 196-212.

Shepard, F.P., K.O. Emery, & E.C. La Fond, (1941). Rip currents: A process of geological importance, *Journal of Geology, 49*, 337-369.

Smith, J.A., & J.L. Largier, (1995). Observations of nearshore circulation: Rip currents, Journal of *Geophysical Research, 100*, 10,967-10,975.

Sonu, C.J., (1972). Field observation of nearshore circulation and meandering currents, *Journal of Geophysical Research, 77*, 3232-3247.

Suhayda, J.N., (1974). Standing waves on beaches, *Journal of Geophysical* Research, *79*, 3065-3071.

Van Enckevort, I.M.J., B. G. Reussink, G. Coco, K. Suzuki, I.L. Turner, N.G. Plant, & R.A. Holman, (2004). Observations of nearshore crescentic sandbars, *Journal of Geophyscial Research, 109*, C06028, doi:10.1029/2003JC002214.

Wood, W.L. & G.A. Meadows, (1975). Unsteadiness in Longshore Currents, *Geophysical Research Letters, 2*(11), 503-505.

Appendix A

Case Study of Great Lakes rip current at Huron, Ohio.

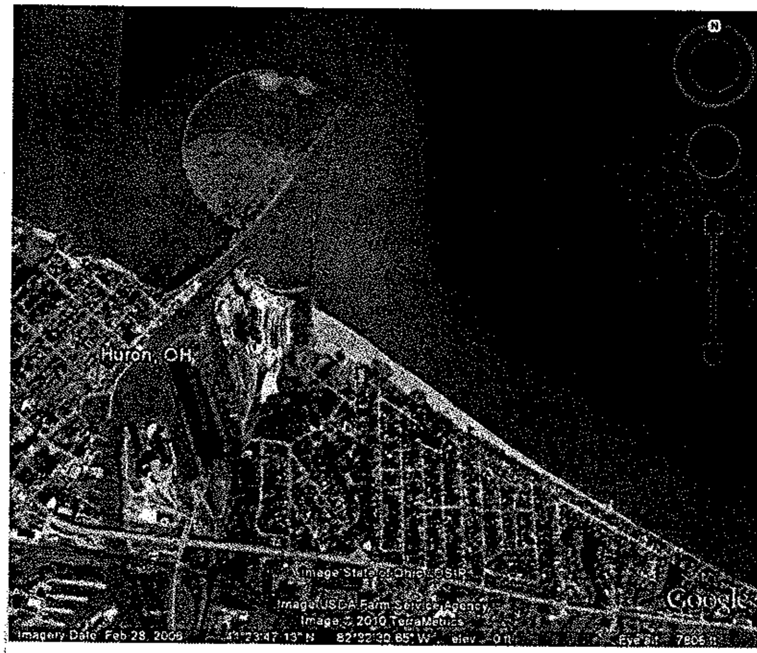

Figure A1. Nickle Plate Beach, Huron Ohio

On July 10, 2002, four men between the ages of 18 to 34, drowned in a strong rip current while attempting to rescue a young woman from the waters off Nickel Plate Beach, located on the northeast side of Huron, Ohio at the west end of Lake Erie (Figure A1). At 18:30 UTC, a woman swimming at a sandbar yelled for help. She was approximately 23 m from shore in about 1.5 m of water. The rip current was pulling her northeast, away from the shoreline. The men entered the water in an attempt to rescue her and drowned. An off-duty firefighter eventually reached the young woman, and was able to rescue her with the help of others from the fire department. Waves, reported to be 1.2 - 1.8 m high, were strong enough to damage a boat used by the fire department during the rescue. Prior to the incident, red flags were posted by the City of Huron to warn swimmers to stay out of the water. Normally, a life guard is on duty, however, once the red flags are posted the life guard is permitted to leave the beach.

NDBC buoy 45005, located 32 km north of the city of Huron in western Lake Erie, reported winds from 040 to 050 degrees (northeast) at approximately 11 m/s for 5 hours prior to the incident. The winds were out of the north and northeast up to 21 hours prior to the incident. During the same time period, the buoy reported waves 1.5 to 2.1 m high and a water temperature of 23 degrees C. The Automated Surface Observing System (ASOS) station at Cleveland, approximately 80 km east of Huron, reported winds from 030 degrees at 7.5 m/s at 15:00 UTC. By 18:00 UTC the winds increased to 12.5 m/s from 040 degrees. At Mansfield, Ohio, approximately 110 km south of Huron, weather observing equipment reported winds between

030 and 040 degrees for four hours prior to the accident and varying between 27 and 32 m/s. At 14:00 UTC. the winds diminished rapidly to 5.3 m/s. The Marblehead water level data gauge, about 25 km northwest of Nickel Plate Beach, indicated the lake reached a peak of 174.60 m Mean Surface Level (MSL) at 15:00 UTC which dropped to 174.44 m by 19:00 UTC and to 174.08 m by 22:00 UTC . After 22:00 UTC, the lake level started increasing again to peak out at 174.45 m at 08:00 UTC.

Note in Figure A1, the Nickel Plate Beach is oriented northwest to southeast, allowing it to be highly exposed to northeast winds. Winds measured at buoy 45005 and at Cleveland airport appear to be most representative for the winds over Nickel Plate Beach at the time of the incident. Studies by Lushine (1991), Lascody (1998), and others have shown that a wind normal to shore would have a much higher probability of producing a dangerous rip current than one from any other direction. In addition to the high waves, reports from people at the beach indicated there was a strong undertow. Surface water temperatures of around 23 degrees C would indicate that hypothermia would not have been an issue.

Gary Packan (2002 personal communication), the director of the Parks and Recreation Department for the city of Huron, Ohio, stated there is no specific criterion for posting Red Flag Alerts other than when the waves look high. The decision to post alerts is up to the City Manager, Parks Director, and/or the Fire Chief with input from local personnel.

The falling lake level indicated by the Marblehead gauge seems to indicate that a seiche had occurred. Studies by Lushine (1991), noted tidal effects play an important role in the enhancement of rip currents. This seiche may have further enhanced the strength of the rip current similar to that which happens on ocean beaches during low tides. The breakwaters that run north of the area may also have caused some channeling and enhanced the waves and subsequent rip currents. Gary Packan said submerged sand dunes off shore change regularly and are not mapped. Channels may have developed in these sand dunes, causing an acceleration of the rip current.

Applying data from the west end of Lake Erie buoy to the rip current checklist, we find that the wave factor would be 3.0, and wind speed factor based on the Cleveland, Ohio airport's Automated Surface Observing System (ASOS) would be a 5.0. Estimating wave period based on wave heights at the buoy we find a period of 4 seconds and a factor of 0. According to the Corp of Engineers (2010), the average lake level for Lake Erie for July, 2002 was 174.24 m and the Marblehead gauge showed a lake level of 174.44 m. We find even though a seiche was occurring and the lake level at Marblehead had dropped .16m, the lake level at the time of drowning was still above the monthly average. Therefore, the lake level factor would then be -0.5 . Adding these values together yielded a rip current risk of 7.5. This is classified as a high risk.